

The admissibility of new techniques of disposing of the dead

To: the Minister of the Interior and Kingdom Relations
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Health Council of the Netherlands



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executive summary

The Corpse Disposal Act states that the bodies of our dead must be disposed of properly.

The Act permits burial, cremation, donation to science, and – in exceptional cases – burial at sea. However, new techniques are now becoming available. These include alkaline hydrolysis, in which bodies are dissolved in a heated liquid. In light of these developments, the Minister of the Interior and Kingdom Relations has asked the Health Council to formulate an assessment framework that can be used to assess the admissibility of new ways of disposing of the dead.

The guiding principles underpinning this advisory report

A Health Council committee, specially created for the purpose, has examined this ethically, religiously, and socially sensitive issue.

In accordance with the request for advice, the Committee has confined itself to the narrow

definition of ‘disposal of the dead’, as just one element of a funeral process that involves numerous ritual practices. Information from various sources leads the Committee to conclude that it is important to society that the bodies of our dead are disposed of respectfully. Existing legislative and regulatory frameworks and accepted practices provide a useful starting point. These encapsulate widely shared principles. Ongoing debates in politics and society, both at national and international level, also provide guiding principles for formulating an assessment framework. After examining all of these aspects in context, the Committee has identified three values – safety, dignity, and sustainability – and has formulated a set of conditions that must be met before a new technique for the disposal of the dead can be considered admissible. These values and conditions are summarised in Table 1 on page 4.

The assessment of new techniques

According to the Committee, alkaline hydrolysis meets the proposed conditions. It concludes that sufficient evidence is available to establish that, in principle, this new technique for the disposal of the dead compares favourably to burial and cremation with respect to sustainability.

However, the technical specifications would have to be further assessed before this technique could potentially be authorised.

Another way of disposing of the dead that is the focus of growing interest is human composting. Here, the body of the deceased individual is placed in a carbon-rich material, where it is decomposed by bacteria and converted into a stable and fertile compost. The process can involve a technical component, to a greater or lesser degree. The Committee concludes that the available information on human composting is, as yet, insufficient to facilitate an assessment based on the conditions specified within the assessment framework.



Table 1. Framework for assessing new techniques of disposing of the dead

Value	Condition	Description
Safety	Guaranteed technical safety	The techniques used must be sound and must pose no risk to operators or to others in the immediate vicinity.
	No emission of high-risk agents	The decomposition process must not involve the release of any agents in concentrations that are harmful to people and the environment.
Dignity	Guaranteed decomposition of the body	The decomposition of the body must be effective, leaving no more than the skeleton.
	No unintentional mixing of bodies and their remains	When disposing of the dead, it must be possible to link bodies and their remains to a specific individual.
	The decomposition process must be shielded from public perception	The decomposition of the body must not generate any unpleasant odours, nor should it be visible to anyone in the vicinity.
	Guaranteed integrity of bodies and their remains	Steps must be taken to prevent the misappropriation – or other improper use – of the deceased individual’s body and bodily remains.
Sustainability	Reduced use of finite resources	The procedure’s technical features and implementation must consume smaller amounts of finite resources than would be the case with burial and cremation.
	Fewer harmful emissions	The technical implementation of this procedure must emit lower levels of harmful substances than burial and cremation.
	Reduced use of available space	The procedure for disposing of the dead should take up less space than burial.



01 introduction



In the Netherlands, over 150,000 people die every year, and that number will grow in the decades to come. The Corpse Disposal Act specifies what must be done with the body of a deceased individual. More specifically, it states that “disposal of the dead takes place by burial, cremation, or another method provided by or in accordance with the law.” Burial and cremation are not the only options, people can also choose to donate their bodies to science. In exceptional cases, burial at sea is permitted.

New ways of disposing of the dead have been developed in recent years. One example is alkaline hydrolysis. This is a technique in which the body is dissolved in a heated liquid to which potassium hydroxide (a highly corrosive substance) has been added. In the Netherlands, this new technique (which is often referred to as ‘resomation’) has been a topic of debate for several years now. The Committee has chosen to refer to it as ‘alkaline hydrolysis’, the name of the chemical process involved (see also 3.1).

The disposal of the dead is a sensitive topic with ethical, religious, and social dimensions. Thus, comprehensive consideration is needed before the law can be amended to include new methods. Accordingly, the Minister of the Interior and Kingdom Relations has asked the Health Council of the Netherlands to develop an assessment framework for evaluation of the admissibility of new ways of disposing of the dead, and to apply that framework to alkaline hydrolysis.¹ To this end, the Council

has appointed a committee of experts whose specialist knowledge spans a range of fields, including anthropology, environmental technology, ethics, law and biological safety. Details of the membership of the Committee on the Admissibility of New Ways of Disposing of the Dead can be found at the end of this advisory report. The Minister’s request for advice can be found at www.gezondheidsraad.nl (in Dutch only).

1.1 Guiding principles and terminology

Funerals for the deceased involve numerous rituals and practices. The exact nature of these rituals and practices depends on people’s philosophy of life, individual wishes, and cultural customs, as well as on the legal frameworks. The disposal of the dead is one element of that entire process. That element is the focus of this advisory report. In formulating the framework, the Committee has endeavoured to identify values that, based on applicable legislative and regulatory frameworks, in current practices and in the Committee’s estimation, are endorsed by a large majority of the population of the Netherlands.²⁻⁵ The assessment framework is not dependent on or restricted to any particular technique. As a result, it can be applied to numerous ways of disposing of the dead, potentially including methods that have yet to be developed. The values have been specified into conditions. This process involved a closer examination of the legislative and regulatory frameworks, and of the existing – and, therefore, accepted – practices involved in, and surrounding, burial and cremation. The partly implicit normative framework



for these ways of disposing of the dead provided a useful starting point for the Committee. In addition, it has attempted to identify the various arguments and considerations involved in the current discourse on new techniques for disposing of the dead.

The Committee has chosen to take into consideration current developments as well. For that reason, in addition to alkaline hydrolysis, this advisory report addresses the admissibility of human composting. Legal developments in the US and Belgium show that composting the remains of deceased individuals is no longer restricted to the realm of science fiction.⁶⁻⁹ Another frequently discussed technique is cryomation (freeze-drying). However, this is not considered here as it is still at the concept stage. Also, to the best of the Committee's knowledge, there are currently no operational cryomation systems anywhere in the world.¹⁰ Similarly, the Committee has decided to disregard techniques that focus on conservation rather than decomposition, such as plastination and cryonics. It has framed the Minister's request in the context of ongoing debates in politics and society. The Committee has confined itself to the narrow definition of 'disposal of the dead', i.e. care intended to achieve the decomposition of the body of the deceased individual.

One topic of debate that arose while this advisory report was being prepared concerned the question of terminology, in particular the term 'corpse'. In some situations, use of the word 'corpse' can be unduly

offensive or distressing.¹¹ At the same time, this term has specific and technical connotations, with regard to the law, for example. Accordingly, in this advisory report, the Committee generally confines itself to the use of the terms 'body of the deceased' or simply 'body'. It uses the word 'corpse' in very few cases, mainly where this term is in keeping with a specific legal context.

1.2 Working method

After conducting a literature review, the Committee concluded that little scientific literature has been published on the topics of human alkaline hydrolysis and human composting. However, there are a number of publications on the use of said techniques for processing dead farm animals. In the course of its literature review, the Committee employed a variety of search strategies. Scientific literature databases, such as PubMed and Scopus, were periodically searched for publications. These searches focused on ways of disposing of the dead, on the destruction of animal remains, and on analyses of how such techniques are embedded in ethical, legal, and societal contexts. Daily searches for relevant publications were conducted, using Google Scholar. Most of the published work in this area is found in English-language technical journals and in standards published by government agencies pertaining to control and management of waste as well as dead farm animals, and water management. In addition, the Committee's members have presented various articles and reports showing how the issues of death and disposal



of the dead are dealt with in the Netherlands and elsewhere. In addition, the reference lists of documents considered by the Committee pointed the way to numerous other publications. Other sources of information included news sites, blogs, and the websites of organisations that provide (or could potentially provide) alkaline hydrolysis and composting services.

The Committee owes a debt of gratitude to the authors of a number of useful reports on alkaline hydrolysis in the Dutch context. TNO has produced three reports on alkaline hydrolysis.¹²⁻¹⁴ Researchers from the Delft University of Technology have also published a report on an assessment framework for alternative ways of disposing of the dead.⁴ Finally, there are two published studies that give an indication of the level of societal support for alkaline hydrolysis in the Netherlands.^{3,5}

In addition to carrying out a literature review, the Committee has consulted experts in composting and other fields. It has also paid several working visits to professionals working in the funeral industry. A hearing was also held, at which interested parties were questioned about the potential authorisation of new techniques of disposing of the dead.²

The list of participants and the report of this hearing can be found at www.gezondheidsraad.nl (in Dutch only).

1.3 International developments

New ways of disposing of the dead are now legally permitted in a number of countries. For instance, alkaline hydrolysis is permitted in a number of regions in Canada, the US, Mexico, Australia, and South Africa.¹⁵ To the best of the Committee's knowledge, that option is not yet available anywhere in Europe. Human composting is permitted in the US state of Washington, as a new way of disposing of the dead.⁷ Legislative initiatives have been submitted in the states of Colorado and California, as well as in Belgium (Brussels).^{6,8,9} Composting is based on expertise, experience, and technology that was developed in the livestock sector, in countries such as the US and Canada, where it has been common practice for many years.¹⁶ In the European Union, the composting of dead farm animals has been permitted (subject to specific conditions) since 2015.¹⁷

1.4 Reading guide

In Section 2, the Committee gives details of the framework for assessing new ways of disposing of the dead. In Section 3, the Committee applies this approach to alkaline hydrolysis and composting.



02 assessment framework



In the Committee's opinion, new ways of disposing of the dead can only be permitted if they respect three values – safety, dignity, and sustainability. To add a practical dimension to its assessment framework, the Committee has specified conditions that should be met.

2.1 Values and conditions

An analysis of the principles and considerations embedded in existing legislative and regulatory frameworks and funeral practices, as well as a study of current developments and topics of debate, led the Committee to develop its assessment framework around the above-mentioned three values. Further support for the Committee's choices in this context emerged during a hearing and in various other settings, following consultations with experts and various professionals.² These values are consistent with previous debates on this topic, in parliament and elsewhere.^{3-5,18,19} Firstly, a new technique must not pose any unacceptable risks to the safety of those involved in the funeral, nor to that of local residents. In addition, from an ethical point of view, it is essential that the bodies of deceased individuals be treated with dignity. Given the existing problems with the environment, global warming, and lack of space, the Committee also feels that, when all is said and done, any new ways of disposing of the dead must be more sustainable than burial and cremation. The above-mentioned three values are equally important. For instance, what if a new technique complies with the values of safety and dignity but is less sustainable than existing ways of disposing of the

dead? The Committee is of the opinion that, in principle, such a new technique would not be permissible.

The Committee has articulated these three values in conditions that new techniques of disposing of the dead should meet. Safety is fundamental. If significant risks have been identified, involving the potential release of harmful agents, for example, then this way of disposing of the dead will only be permissible if measures (technical or other) are taken to manage these risks. Dignity is less easily translated into practical measures, because it involves highly variable factors, such as culture, philosophy of life, and personal preferences. Take cremation, for example. While for many years this technique was considered controversial, it has now become the most widely used way of disposing of the dead in the Netherlands.^{20,21} Yet this method is unacceptable to groups such as Orthodox Christians, Muslims, and Jews, because cremation runs counter to the tenets of their faith.^{2,22,23} The Committee did not deem its task to devote further ethical consideration to this matter, or to express any opinions about it. It has focused on the principles underpinning existing practices – and legislative and regulatory frameworks – pertaining to burial and cremation in the Netherlands. The Committee has also examined practices in other countries and cultural contexts. Based on its findings in this area, the Committee has been able to derive a number of conditions pertaining to dignity.²⁴ These concern practices and rules that collectively contribute to a considerate and respectful way of disposing of the dead.



Cremation and burial also set the standard for the conditions relating to sustainability.

2.2 Safety

New techniques for disposing of the dead should not pose any unacceptable risks to professionals and volunteers working in the funeral industry, nor to the next of kin, nor to anyone else present at the funeral. The same applies to people who could be exposed to any physical, chemical, or biological agents that might be released into the environment. Safety risks relate to health and physical safety. Anyone wishing to provide a service based on a new technique must either demonstrate that no such risks are involved, or that the risks are manageable, in terms of the applicable occupational hygiene and environmental hygiene standards. The Committee has set the following conditions for ensuring the safety of new ways of disposing of the dead:

1. *Guaranteed technical safety*: the systems must be technically sound. Technical safety is partly ensured by existing regulatory frameworks, such as the Health and Safety Catalogue for funeral care, the Machinery (Commodities Act) Decree, and the Hazardous Substances Publication Series.²⁵⁻²⁷ Existing techniques of disposing of the dead have been based on principles that can be used to ensure technical safety. For example, the Activities Decree contains provisions on ‘Air quality regulations for crematoriums’, which sets out the requirements for effective combustion, proper maintenance, and the associated

operational checks.²⁸ The Committee recommends that the technical safety of new ways of disposing of the dead should be regulated in a similar fashion.

2. *No emission of high-risk agents*: prior to their death, deceased individuals might have undergone intensive chemotherapy or they may have been a carrier of dangerous bacteria and viruses. The funeral industry has developed guidelines to protect workers from contamination or infection.²⁵ In addition, radiological risks may be involved. As a matter of fact, a recent report by the National Institute for Public Health and the Environment (RIVM) showed that the potential level of ionising radiation exposure for employees and others involved in the funeral industry is low.²⁹ Within the industry, there are calls for a notification requirement to be imposed on physicians and coroners in cases where, prior to their death, the deceased individuals were treated with isotopes and other high-risk agents.³⁰ This was in response to an incident in which a crematorium had to suspend operations when its cremation oven became contaminated with isotopes.³¹ Hazards to individuals and to the human environment can arise if high-risk agents are released into the air, soil, or water during or after disposal of the dead. This could involve metals present in the body (such as mercury, cadmium, or copper), or multi-resistant bacteria that can survive outside the body for extended periods of time. Any risk of contamination must be kept to an absolute minimum. Thus, with regard to new ways of disposing of the dead, it is important to know whether these can



eliminate high-risk agents effectively, and whether they comply with the regulatory requirements.

2.3 Dignity

The dead must be treated with dignity and respect throughout the funeral process. This includes transportation, washing and grooming, viewing the body, the funeral service, the disposal of the dead body, and dealing with any bodily remains (such as the ashes) after disposing of the body.^{23,32,33}

Thus dignity is enshrined in the interests of everyone who is, in any way, involved in this process. These range from the next of kin, who want their wishes and those of their deceased loved ones to be respected, to funeral industry employees, who observe rules for respectfully dealing with the dead. As previously stated, for the purpose of creating an assessment framework, the Committee has focused solely on the actual techniques used to dispose of the dead. In this context, dignity primarily relates to the deceased individual whose body is to be disposed of, and to any bodily remains after disposal of that body.³³ The Committee has specified the following conditions:

1. *Guaranteed decomposition of the body*: any new technique of disposing of the dead must effectively decompose the body of the deceased individual into a product that no longer contains any degradable organic substances, or into a product that is accepted elsewhere for further biological decomposition, that complies with the applicable requirements concerning discharge or reuse. It must be

possible to intervene in the process, should that prove necessary. It is in society's interest that decomposition actually takes place. In other words, decomposition must proceed effectively, and the care and disposal of bodies should not be passed on to future generations. A case in point are burials where skeletonisation is facilitated by the Netherlands' ten-year grave lease period. This period of time is usually sufficient for this purpose.³⁴

2. *No unintentional mixing of bodies and their remains*: bodies and remains must remain individually distinguishable until the end of the grave lease period or until the ashes are handed to the next of kin. However, there are additional standards that serve to underline the importance of being able to identify individuals. Each coffin or urn contains (remains of) a single individual. A single coffin is buried, marking the official commencement of the grave lease period. This guarantees individuality – the body of the deceased will not be mixed with another individual's body material, and all parts are located in an identifiable site.³⁵ Also, with reference to debates in the Dutch House of Representatives, the Committee can imagine that joint disposal should be possible in special cases, for instance, if a mother and child were both to die in childbirth.^{19,32} Articles 50 and 65 of the Corpse Disposal Act lay down rules concerning the individual traceability of the deceased, their bodies, and remains, by means of registration numbers and registries (including publicly accessible registries). Article 9 of the Corpse Disposal Decree requires that cremation be carried out in a way



that eliminates any possibility of ashes becoming mixed with those of another body or of confusing the identity of an individual's ashes.

A maximum of three bodies may be buried in a grave at different times, provided that they are separated by a layer of soil. Cemetery managers are permitted to merge bodily remains from two (or more) deceased individuals into a single level, but not until the end of the ten-year grave lease period that commenced when the last body was interred.³⁴ Based on this, the Committee infers that traceability, individuality and an identifiable site where the body (or bodily remains) are located are the key standards underpinning the condition concerning the prohibition of unintentional mixing. Once the mortal remains have been given to the next of kin, the latter are free to mix these remains (or parts thereof) with those of other deceased individuals.

3. *The decomposition process must be shielded from public perception:* the condition stipulating that decomposition of the body of the deceased individual must be shielded from public perception avoids any untoward distress. Burial usually involves placing a body under the ground, so the decomposition process is imperceptible – the decomposition of the body can neither be seen nor smelled. In accordance with this condition, it is also stipulated that the exhumation of bodies and the clearing of graves must be out of public sight.³⁴ Interring the coffin above ground, in a sealed niche (e.g. wall-niche tombs, niche galleries, and mausoleum-niche tombs) is also a recognised form of burial. The Corpse Disposal Decree states that it

must be possible for air to enter and leave the burial space without exposing anyone to unpleasant odours. Cremation is subject to similar provisions with regard to shielding the process from public perception. To this end, there are regulations governing the treatment of flue gases, by means of adsorption and filtering.²⁸ Current regulatory frameworks do, however, provide scope for individual staff or next of kin to observe the process of disposal of the dead, for example during interment in the grave, when the coffin is placed in the cremation oven, or for the purpose of monitoring safety.

4. *Guaranteed integrity of bodies and their remains:* while deceased individuals are no longer legal persons and can, therefore, no longer claim individual rights, their bodies do enjoy legal protection. The deceased individual has ongoing rights relating to personality, including the right to bodily integrity.^{32,36,37} This protects the body after death 'out of respect for the human individual and their dignity'.³⁷ The Dutch Criminal Code (DCC) contains various articles emphasising that the dead deserve protection. For example, the unlawful exhumation of a body is punishable, as is moving or transporting an exhumed body (Article 150 DCC). Thus, the Committee feels that new techniques of disposing of the dead should be designed in a way that eliminates any possibility, within reason, that all or part of a deceased individual's body can be removed.



2.4 Sustainability

According to the Committee, a focus on sustainability is in keeping with current developments in the funeral industry and with general policy measures aimed at protecting the environment, nature, and the climate.³⁸⁻⁴⁴ The Committee suggests that sustainability should be measured against existing techniques for disposing of the dead.

The guiding principle should be that, when all is said and done, new ways of disposing of the dead must create less of an environmental burden than cremation and burial. The conditions relate in particular to the use of finite raw materials, to the emission of harmful agents, and to the physical space taken up when disposing of the dead.

Various indicators of sustainability can be quantified and modelled, but the concept of sustainability also has normative aspects – what are the key indicators and how much consideration do they merit? Being cognisant of this complex theme, the Committee has restricted itself to issues that feature in the debate about the disposal of the dead. It feels that neither its remit nor its membership qualifies it to comment further on LCA models (LCA stands for *life cycle analysis*, a method used to evaluate the environmental impact of a process, comparing it to alternative options). However, it does have the impression that the LCAs carried out by TNO on burial, cremation, and alkaline hydrolysis have paved the way for standardisation.^{13,45} According to the Committee, reports from other countries tend to support this conclusion.⁴⁶ It recommends that

standardisation in this area be further developed, to facilitate the assessment of future techniques for disposing of the dead. To ensure that new techniques are sufficiently sustainable, the Committee has proposed the following conditions:

1. *Reduced use of finite resources*: disposing of the dead involves the use and consumption of finite resources. These include the wood and glue used in coffins, the fuel for excavators or crematoriums, gravestones or urns for cemeteries or ashes, or the chemicals used in alkaline hydrolysis, and the use of raw materials in the further biological decomposition of residual products (as with alkaline hydrolysis). If the system boundary is shifted any further, then aspects such as transport, facilities, equipment, or the construction of a cemetery, for example, must also be taken into account in the LCA models.
2. *Fewer harmful emissions*: the emissions of harmful substances must be lower than the highest emission levels produced by cremation, in particular. This includes greenhouse gases (expressed in kilo/CO₂ equivalents), nitrogen oxides, sulphur dioxide, and particulate matter. The developers and users of crematoriums are currently working on innovations to boost their operational efficiency. In this context, the Committee proposes the use of an update obligation when determining cremation emissions.
3. *Reduced use of available space*: in the case of burials, the body must remain in the ground for at least the grave lease period. During that time, this burial plot cannot and may not be used for other purposes.



This does not take into account situations in which cemeteries or ash scattering areas are used as recreational areas or nature conservation areas. New techniques of disposing of the dead should take up less space than burial.

As stated, efforts to determine sustainability involve quite a few uncertainties and normative aspects. Accordingly, the Committee would like to add that the conditions in question should be considered as an interrelated whole. On balance, new techniques should achieve a better score in this respect than existing ways of disposing of the dead.



03 two new techniques assessed



The Committee has applied its assessment framework to two new techniques for disposing of the dead that are currently in the spotlight – alkaline hydrolysis and composting. It concludes that alkaline hydrolysis in principle does, and composting does not or does not yet, comply with its proposed conditions.

3.1 Alkaline hydrolysis

A number of countries have already authorised the use of alkaline hydrolysis as a new way of disposing of the dead. In the Netherlands, both the funeral industry and the Parliament have been interested in this technique for about ten years now. As a result, various studies have been conducted in this area.^{3-5,12-14} The term ‘resomation’ is often used in this context, but the Committee prefers the technical term, alkaline hydrolysis (see box).

Terminology

The term ‘resomation’ derives from the Greek word ‘*resoma*’, meaning rebirth of the body.⁴⁷ *Resomation Ltd.*, a UK manufacturer of alkaline hydrolysis equipment, uses this term to emphasise that a hydrolysed body is converted into organic elements that quickly return to the water cycle, and are thus ‘returned’ to nature. Thus ‘*resomation*’ is, in fact, a marketing term. For this reason, the Committee prefers to use the technical term, alkaline hydrolysis.

Various other terms are currently in vogue, such as *aquamation*, *water cremation*, *flameless cremation*, *green cremation* and *bio-cremation*.^{39,44} These terms link alkaline hydrolysis to the much more familiar process of cremation. This technique is also presented as an environmentally friendly way of disposing of the dead, which might appeal to those who value sustainability.^{48,49}

The comparison with cremation is unsound. The word ‘cremation’ comes from the Latin word ‘*cremare*’, meaning ‘to burn’. In cremation, the body is incinerated by burning. All of its component substances end up either in the ashes or in the air. Following incineration, the process is complete. Alkaline hydrolysis involves no *combustion* at all, instead the body is *dissolved* and its organic components end up in liquid form.

3.1.1 The process of alkaline hydrolysis

Alkaline hydrolysis was developed in the late 19th century, as a way of producing organic fertiliser from dead farm animals.⁴¹ In short, alkaline hydrolysis involves dissolving the body of a deceased individual in a hot liquid containing potassium hydroxide (see box).



Process description

Alkaline hydrolysis is a chemical process in which the body of a deceased individual is first placed in a steel pressure vessel. Once the vessel has been closed, water and potassium hydroxide are added. The vessel is then pressurised and the water is heated. The maximum temperature varies from about 100 to 150 degrees Celsius, depending on the type of system being used, and the pressure. The combined action of heat, water, and potassium hydroxide, causes the body's organic substances to dissolve in the liquid. This fully automated process takes two to ten hours, depending on the temperature and on the weight of the body to be processed. In addition to heating the liquid, a complete cycle involves various cooling and rinsing steps.

There are three types of residual material:

- The bones. These are dried and ground into a white powder, which consists largely of calcium. As with cremation ashes, this powder can be given to the next of kin.
- Any prostheses, fillings, and medical devices. These can be collected and disposed of in the prescribed manner. They could also be reused, if appropriate.
- The liquid used during hydrolysis. This effluent, which has a volume of approximately 1,500 litres, consists of water, potassium hydroxide, and the dissolved organic substances (sugars, amino acids, salts, and fatty acids). The effluent has a high pH, and contains no DNA or RNA.^{43,50-52} The pH is reduced to less than 10 by adding sulphuric acid.

As stated, the comparison with cremation is unsound. During the cremation process (combustion), organic substances are directly converted into carbon dioxide and water. Any remaining water evaporates. Nutrients that are bound to organic substances either end up in the ash or are released into the air. In the case of alkaline hydrolysis, this requires a post-treatment step. The effluent typically is discharged via the sewer. After being treated in the sewage treatment plant, it enters the surface water. Because of this, various (mostly American) organisations reject alkaline hydrolysis, as they do not deem it to be a dignified and respectful way of disposing of the dead.^{22,40,44,48,53-55}

However, there may be alternatives to discharging the effluent into the sewer system. For example, the effluent can be treated locally, immediately after completion of the alkaline hydrolysis process.

When using a purification method that preserves nutrients (such as anaerobic purification), the locally purified effluent can be used to fertilise fields, commercial forests, or places of remembrance, for example.

Depending on the wishes of the next of kin and the facilities available at the funeral company, some of the processed effluent could be given to the next of kin. Another option would be to use the effluent directly (i.e. without first treating it) as a fertiliser.² A third processing method is to transport the effluent by road tanker to a sludge digester, where it would be used to produce biogas.



3.1.2 Assessment

How well does alkaline hydrolysis score, in terms of the conditions specified within the assessment framework? The Committee addresses these points, step by step.

Safety

1. *Guaranteed technical safety*: TNO has investigated the process safety of alkaline hydrolysis (referred to as ‘resomation’ in its report).

It concluded that “in terms of safety there are no significant reasons why resomation should not be legalised in the Netherlands”.¹⁴

RIVM has reviewed the TNO report, and found no inaccuracies or omissions.⁵⁶ On this point, other analyses have also reached the same conclusion.^{50,57} The Committee emphasises that, here too, standard procedures for the installation of technical systems must be followed.

These include the certification of individual parts and processes, operating the equipment in accordance with the manufacturer’s instructions, and providing operator training courses, as well as carefully maintaining and periodically inspecting the equipment.

If there is full compliance in this regard, the Committee considers that technical safety has been guaranteed.

2. *No emission of high-risk agents*: alkaline hydrolysis chemically decomposes all organic substances, including prions and medication.^{50-52,57} Accordingly, this also includes any bacteria, viruses, parasites, fungi and yeasts (harmful or otherwise) that may be present

in and on the body of a deceased individual. According to TNO’s analysis, the concentrations of substances in the effluent are below those stipulated in sewage treatment plant standards.⁵⁸

Dignity

1. *Guaranteed decomposition of the body*: alkaline hydrolysis is an effective way of converting a body into liquid form.⁵² By the time that the process is complete, the body’s organic substances have been fully dissolved in the effluent. The introduction of a post-treatment step, as described above, might be an option. The bones and teeth become fully mineralised. Once these have been dried, they are ground into a stable, white powder that contains elements such as calcium.

2. *No unintentional mixing of bodies and their remains*: alkaline hydrolysis systems are basically designed to chemically decompose a single body per cycle. The residual material includes bones, which are ground into powder. This residual material is comparable to cremation ashes, as defined in the Corpse Disposal Act. The Committee takes the view that registering, retrieving, storing, interring, or scattering this material, or handing it over to the next of kin, can be carried out in line with the applicable rules for cremation ashes.

3. *The decomposition process must be shielded from public perception*: alkaline hydrolysis takes place in a sealed stainless steel vessel. Nevertheless, there have been reports of a persistent, unpleasant odour in working areas adjoining the alkaline hydrolysis system.



It is unclear whether or not this odour might cause distress to anyone in the vicinity.¹⁴ Technical measures, such as the use of odour filters, could solve any unpleasant odour issues.

4. *Guaranteed integrity of bodies and their remains*: the entire system, including the sealed container, is housed indoors.

Sustainability

1. *Reduced use of finite resources*: the Committee has taken note of two LCA studies into the use of raw materials in alkaline hydrolysis, as compared to cremation and burial. One UK study showed that alkaline hydrolysis consumes fewer raw materials than cremation, for example.⁴⁶ An LCA carried out by TNO obtained similar results.¹³ In addition, the Committee draws attention to an American study into methods for processing dead farm animals. It concludes that, in terms of raw material use, alkaline hydrolysis compares favourably to other destruction techniques.¹⁶
2. *Fewer harmful emissions*: compared to cremation, alkaline hydrolysis offers some clear advantages. For instance, fuel consumption and the associated CO₂ emissions are much lower.^{16,59} Furthermore, relatively few harmful substances are released in this process.^{16,52,60} In a review of a recent TNO report on alkaline hydrolysis, RIVM reports that this process can generate unpleasant odours via the sewers, due to the formation of gaseous diamines.^{14,56} Specific technical remedies could be taken here as well.

3. *Reduced use of available space*: calculations by TNO show that alkaline hydrolysis makes much less use of the available space than burial. These calculations show that the grave lease period, in particular, imposes a heavy burden on this space.¹³ The bone powder left over after alkaline hydrolysis is similar to cremation ashes, so the use of space involved will be similar to that involved in cremation.

3.1.3 Conclusion

Based on scientific publications and reports from the Netherlands and elsewhere, the Committee concludes that alkaline hydrolysis in principle complies with the specified conditions concerning safety, dignity, and sustainability. Here ‘in principle’ means that, just as with burial and cremation, the technical procedures involved need to be carried out in accordance with the applicable regulations. The Committee is of the opinion that, regarding sustainability, sufficient evidence has been provided to show that alkaline hydrolysis compares favourably to burial and cremation. However, as far as the Committee is concerned, technical specifications would have to be further examined before this way of disposing of the dead could potentially be authorised.

3.2 Composting

While alkaline hydrolysis is now permitted in several countries, the US State of Washington is currently the only place where human composting is permitted. There have been calls in Belgium and a number of other



American states for this to be made legally possible there as well.

The advocates of this technique argue that, with regard to the disposal of animal carcasses, composting has proven its worth in practice, and that it is an environmentally friendly method.^{61,62}

3.2.1. Process description

Composting the bodies of dead farm animals is a long-standing, proven, and scientifically researched practice.^{16,63,64} Various government agencies and institutions, particularly in the US and Canada, have published manuals on this topic.⁶⁵⁻⁶⁷ In composting, the body is first placed on carbon-rich material, such as wood chips, sawdust, and leaves, after which it is covered with more of this material. Nitrogen, moisture and oxygen are also essential for the composting process. Once the compost heap has been prepared, the microbiological activity of bacteria and fungi starts to decompose the body, causing it to warm up. If a temperature of 55°C is maintained for a few days, this is sufficient to kill most pathogens. When this process is performed correctly, the resulting residue is a stable compost.

There are a range of different composting techniques. Some of these are more natural and largely unmanaged, for instance where an animal's body is simply laid in a compost heap. Others involve more technologically controlled forms of composting, in which animals' bodies are placed in a sealable, rotating vessel. Here, the decomposition conditions (such as

oxygen level, temperature, and moisture content) are continuously monitored.^{16,64} Depending on the size of the body to be composted and the technique involved, the composting process can take from several weeks to about a year.⁶⁸ It should be noted that technologically-controlled composting processes are comparatively quick.

Both the natural and technological variants of composting are the focus of growing interest as potential ways of disposing of the dead.^{69,70} In human composting, the bones are mechanically fragmented during the process, to generate useful compost.² For several years now, the Metamorfose Foundation in Belgium has been calling for the natural variant to be legally designated as a permissible way of disposing of the dead.⁶²

The Parliament of the Brussels-Capital Region has now adopted a so-called Draft Order to make composting legally possible.⁶ The US State of Washington passed an Act in 2019 that allows the technological variant to be used as a technique for the disposal of the dead.⁷ This means that, with effect from May 2020, human composting will be permitted by law. The Act refers to this process as *natural organic reduction*.⁶¹ In February 2020, the US states of Colorado and California developed legislative initiatives to designate *natural organic reduction* as a technique for the disposal of the dead.^{8,9} Inspired by developments in Belgium and the US, an initiative has been launched in the Netherlands to start scientific research into human composting.⁷¹



3.2.2 Assessment

The Committee has established that there is a lack of scientific data in this area, as no human composting studies have been published so far.

One line of inquiry concerned the scientific basis for the State of Washington's decision to authorise this way of disposing of the dead. However, the Committee's requests for information on this matter have elicited a very limited response. Nor did the recent hearing bring to light any reports about human composting.² Thus, in that sense, this situation is unlike that of alkaline hydrolysis. At the same time, European regulatory frameworks and reports from European institutions make it clear that animal composting is not without its problems.^{17,72,73} For instance, the process used when composting pigs must comply with strict rules. Moreover, it is not allowed to release the end product in the environment; it has to be incinerated.^{17,73} This is because the temperatures reached during the process cannot adequately guarantee that high-risk agents, such as prions, would be completely destroyed.^{16,73} There are also concerns that some medications, including euthanasia drugs,^{67,74} are not effectively broken down by this process.^{16,64,75-77}

The Committee is of the opinion that, given the current inadequate state of knowledge, it is difficult to assess the extent to which human composting complies with the full suite of conditions imposed on admissibility.

However, even in the absence of any further research, it is still possible to give a verdict regarding individual elements of this issue. It can be

assumed that this way of disposing of the dead involves a reduction in the use of available space and finite raw materials, for example. Nevertheless, the Committee still has reasonable doubts about the extent to which this method complies with the other conditions of the assessment framework. This concerns the emission of high-risk agents, the decomposition of the body, and the extent to which the decomposition process is shielded from public perception.

In this context, the design and control of the composting process are of key importance. The more technical the process (for example, the use of individual containers, systems for monitoring the temperature and the level of oxygen being supplied, as well as various control options), the greater the chance of a positive verdict with regard to admissibility. The Committee has the impression that the American method is partly based on the use of these types of techniques. However, it does not have sufficient information to develop an informed opinion about the quality of that process.

In summary, the Committee concludes that the available information on human composting is, as yet, insufficient to make possible an assessment based on the conditions specified within the assessment framework.



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The Committee and the expert consulted

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Observers

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- Dr M.H.M.M. Montforts, RIVM, Bilthoven

Scientific secretaries

- Mr E.J. Schoten, Health Council, The Hague
- Dr V. Toom, Health Council, The Hague

For the purpose of preparing this advisory report, the following expert was consulted

- Dr A.H.M Veeken, Composting expert, Attero



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