SLOVENSKI STANDARD

SIST CR 13686:2002

01-januar-2002

Embalaža - Optimizacija energijske predelave odpadne embalaže

Packaging - Optimization of energy recovery from packaging waste

Ta slovenski standard je istoveten z: CR 13686:2001

ICS:

13.030.99	Drugi standardi v zvezi z odpadki	Other standards related to wastes
55.020	Pakiranje in distribucija blaga na splošno	Packaging and distribution of goods in general

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Packaging - Optimization of energy recovery from packaging waste

Emballage - Optimisation de la valorisation énergétique des déchets d'emballages

Verpackung - Optimierung der energetischen Verwertung von Verpackungsabfällen

This CEN Report was approved by CEN on 2 June 1999. It has been drawn up by the Technical Committee CEN/TC 261.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document has been prepared by CEN /TC 261, "Emballage".

This document is actually submitted to the publication.

Introduction

The Directive on Packaging and Packaging Waste, Annex II, 3(b) states that *Packaging waste processed for the purpose of energy recovery shall have a minimum inferior calorific value to allow optimization of energy recovery* (Ref. 1).

The Commission's Mandate M 200 Rev. 3 asks CEN to propose a standard on *Requirements for packaging recoverable in the form of energy recovery, including specification of minimum inferior calorific value* **(**EN 13 431).

Energy recovery is defined in Article 3.8 of the Directive : *'energy recovery' shall mean the use of combustible packaging waste as a means to generate energy through direct incineration with or without other waste but with recovery of the heat.*

EN 13431 shall apply to packaging placed on the market in order to allow optimization of energy recovery of packaging waste by specifying minimum inferior calorific value and other supplementary requirements. It cannot and does not consider conditions or contaminants of packaging waste at arrival to furnace at the energy recovery plant.

1 Scope

The objective of this report is to identify and define properties of packaging and packaging waste to allow optimization of energy recovery.

This report takes a wide approach to the process of energy recovery in order to identify the items to be standardised according to the Directive and the Mandate.

2 Terminology

Net calorific value (inferior calorific value), Q_{net} : defined in ISO 1928 :1995 (Ref. 3).

Required energy H_a : energy necessary to adiabatically heat the post combustion substances of a material and excess air from ambient temperature to the specified final temperature.

Calorific gain : the positive difference between the energy released on combustion of a material (the net calorific value) and H_a.

Available calorific gain : recovered heat providing useful energy.

3 Packaging and packaging waste

The statement in Annex II of the Directive quoted above refers to ***packaging waste***, whereas the Mandate wording refers to ***packaging***. Packaging waste can be used for energy recovery, but it is the packaging placed on the market that has to meet the specific requirements for energy recovery and therefore is subject to meeting the standard. The link between the Directive and the Mandate can be described in the following manner :

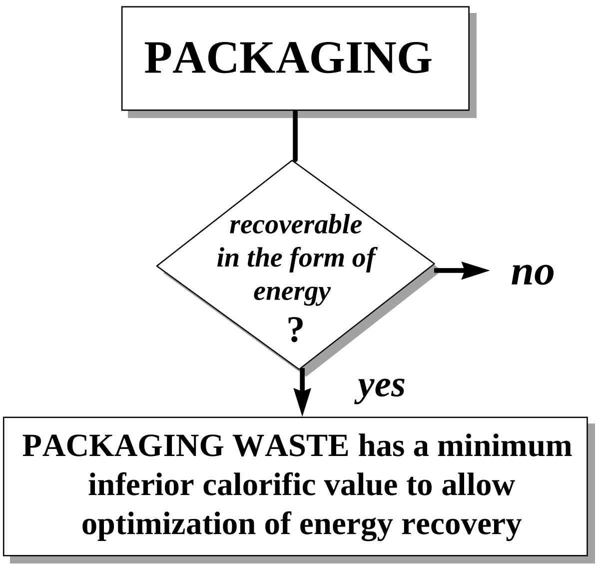

Figure 1

As shown in Figure 2, packaging materials, packaging, used packaging and packaging waste form a sequence from production and consumption to waste, without intrinsic change of the chemical material properties which are essential for energy recovery.

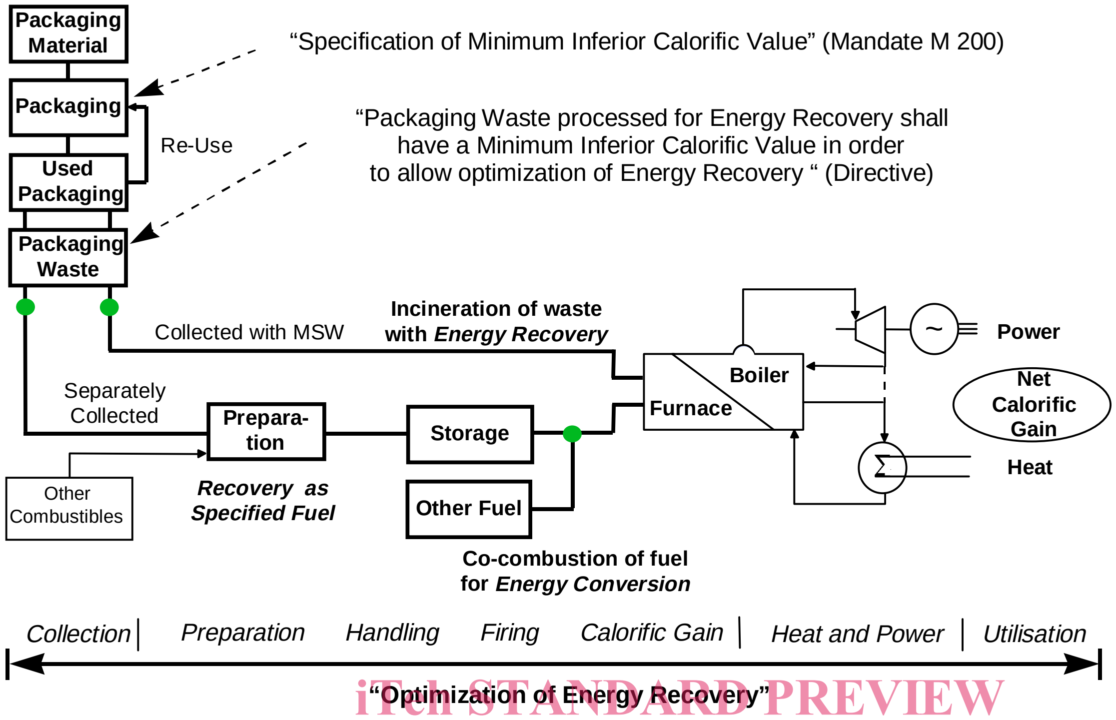

Figure 2 - The Overall System of Optimization of Energy Recovery

4 Optimization of energy recovery

The objective of this report is to identify and define properties of packaging and packaging waste to allow optimization of energy recovery. ***Optimization of Energy Recovery*** from packaging waste involves the overall system including properties of packaging, waste collection systems, preparation, storage and energy conversion to provide net calorific gain as shown in Figure 2. Some steps included in the overall system are not related to the packaging itself, and therefore not considered influential to the requirements of the packaging. Combustion plants, for example, are subject to specific regulation and the use of produced energy depends on local circumstances.

Figure 3 shows the relationship between packaging, packaging waste and their relevant requirement in the framework of the overall system of optimization of recovery in the form of energy. These issues are discussed in detail in the following.

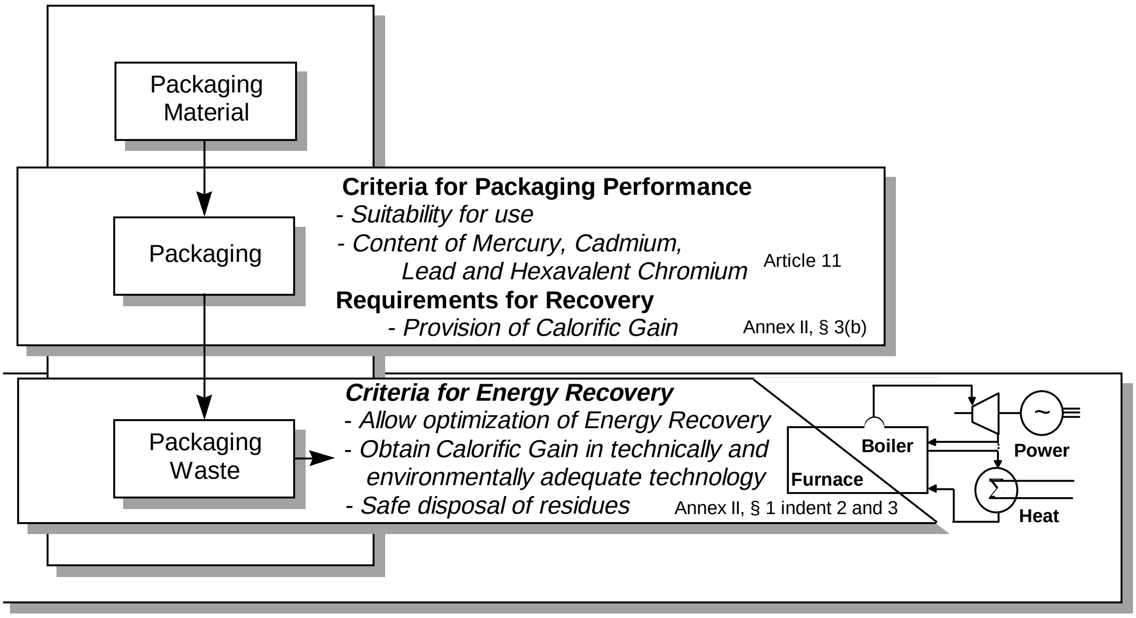

Figure 3 - Relevant Issues of Directive of Packaging and Packaging Waste and Mandate M 200 Rev. 3

Collection system and preparation

In order to optimize energy recovery from used packaging, the waste collection system should be designed and managed so that the energy content and other fuel properties of used combustible packaging are preserved. The extent of preparation necessary to transform packaging waste into a fuel, depends on the requirements of the actual energy conversion plant.

Today, two different methods of collection and preparation or pre-treatment are prevailing (Figure 2) :

1) packaging waste is collected with other Municipal Solid Waste (MSW) for direct incineration in MSW incinerators. This type of incinerator is efficient, proven and requires little pre-treatment of the mixed waste ;

2) separation of combustible waste gives a combustible fraction, known as Refuse-Derived Fuel, RDF. Source separation and preparation of combustible packaging waste allows for the production of an energy-rich solid fuel with specific properties (Packaging-Derived Fuel, PDF).

   These derived fuels can be used as a single fuel or used in co-combustion with other fuels in existing solid fuel fired combustion systems.In all these processes, combustible packaging waste substitutes primary fuels.

Energy conversion and generation of net calorific gain

Energy conversion of chemically bound energy to generate net calorific gain consists of three main process steps :

- combustion of a fuel in a combustion chamber, resulting in hot flue gases and solid residues, such as ashes and slag ;

- utilization of the heat content of the hot gases in a heat recovery system ;

- conversion of the recovered heat to provide end-use energy in the form of electricity and/or heat.

Combustion

Combustion efficiency is related to the degree of completeness of combustion. It is mainly affected by fuel particle size, fuel-to-air ratio, temperature, residence time and turbulence (mixing of fuel and air) in the furnace. Products of incomplete combustion are carbon monoxide, volatile organic compounds and soot particles in flue gas and unburnt carbon in ashes and slag. In the combustion process, organic substances are decomposed and transformed into gaseous components. Depending on the combustion conditions, inorganic compounds are either unaffected or transformed into insoluble oxides, sulphides, or water-soluble chlorides and sulphates. High combustion efficiency therefore means minimisation of these pollutants.

In grate fired mass burn systems the dominant part of ash leaves the furnace in the form of bottom ash (slag). The amount of organic carbon in bottom ash is low, and the slag may be used for construction applications. High temperature and the presence of acid components volatilise certain heavy metals, e.g. cadmium and zinc, from the bottom ash to fly ash and filter residues. This can be seen as a positive clean-up effect of the slag (Ref. 4). Fly ash and filter residues always contain high concentrations of fuel pollutants and require special treatment. In accordance with current regulations, modern Waste-to-Energy plants are well equipped to deal with these pollutants in an environmentally sound way (Ref. 5).

Utilization of the heat content of combustion gases

The heat content of combustion gases is recovered in the boiler as steam or hot water. The heat exchange efficiency is proportional to the temperature difference between the hot and cold sides of the system. General aspects on generating net calorific gain are :

- the facility is designed for a specified type, quality and range of fuel. A fuel that is unsuitable for the actual equipment may affect the energy recovery process negatively and cause fouling, slagging and corrosion in the boiler. As a result, frequent soot blowing and shut downs for mechanical clean-up and repair work will be necessary. This reduces the plant availability ;

- the internal energy consumption of blowers, pumps, extensive flue gas cleaning equipment etc. reduces overall efficiency and the net calorific gain.

Overall efficiency and net calorific gain are optimized by minimising thermal losses, e.g. by :

- extensive cooling of the hot flue gases in the boiler ;

- utilization of the remaining heat in the flue gases after the boiler for drying and preheating of the fuel, or for other process steps.

Conversion of thermal energy to electricity and/or useful heat

The efficiency of energy conversion to electricity and/or heat depends on temperature and pressure of generated steam.

Combined generation of electricity and steam or hot water for heating purposes gives overall energy utilization of more than 70 %. This combination is favourable to the optimization of energy recovery. Condensation of water vapour in the flue gases may further increase energy utilization.

5 Requirements for packaging recoverable in the form of energy

Calorific Gain

The principal requirement for packaging to be recoverable in the form of energy is that it is combustible under ordinary conditions (Ref. 6). and, in order to allow optimization, capable of providing calorific gain. This means that the net heat of combustion, Q_{net}, of the packaging shall exceed the energy required, H_a, to raise the temperature of its combustion products, residues and excess air to the required temperature, as given in Ref. 5. This is evaluated in Chapter 6 and is true for all organic materials and most multi-material light-weight packaging containing a major amount of organic material.

Ash content

The energy recovery process gives a substantial total reduction of the volume of waste and provides slag that may be recycled. Average combustible packaging has an ash content lower than MSW or coal. The requirement for calorific gain, by implication, limits the total ash content. The limit varies according to the packaging composition (see Table 1 and examples in Chapter 9). Efficient combustion limits the content of unburnt organic matter in ash, and as a result only little energy is lost in slag and ash residues. The ash content of packaging is therefore not an important issue with respect to optimization of, or suitability for energy recovery.

Other supplementary requirements

Other supplementary requirements could be on acid forming substances, heavy metals and other hazardous substances in combustible packaging. These subjects are covered in Ref. 6. The following can be stated :

- the content of acid forming substances, i.e. sulphur, nitrogen and chlorine, in the fuel feed to an energy conversion plant is determined by the design and regulated emission limits of the plant. MSW incineration plants are equipped to deal with average packaging waste. The final disposal of residues from incineration is also subject to regulation ;

- the fate of heavy metals in incineration is thoroughly described in Refs. 4, 7 and 8. The emission of these is regulated. Heavy metals do not normally play a major functional role in combustible packaging materials, since a major part of which is used for food application. Mercury, cadmium, lead and hexavalent chromium are regulated in Article 11 of the Directive (Ref. 1) ;

- any other hazardous components, that may be present in packaging waste, will be decomposed by the high temperature of the combustion process.

6 Theoretical determination of calorific gain

According to the definition in Ref. 6, a combustible material is defined as capable of releasing energy by burning. By standard thermodynamic procedure, its characteristics as an energy generator can be calculated. In order to allow optimization of energy recovery the released energy must be high enough to provide calorific gain in the combustion process.

The net heat of combustion (net calorific value), Q_{net} , of a material is the amount of heat released when it burns and when all water remains in the gas phase. It depends on chemical composition of the material. The rate of heat release also depends on the physical properties of the material. In order to provide calorific gain, Q_{net}, of a material shall exceed the amount of energy required, H_a, to adiabatically raise the temperature of the post-combustion substances (including excess air) from ambient temperature to the specified final temperature. A calorific gain is obtained when Equation (1) is fulfilled :

$$Q_{net} - H_a > 0 \quad (1)$$

The **net calorific value** of a packaging consisting of different constituents can be calculated according to Equation (2) :

$$Q_{net} = \sum_{i=1}^{n} f_i \, Q_{net,i} \quad (2)$$

where

Q_{net} net calorific value of the packaging ;

f_i fraction of constituent i in the packaging ;

$Q_{net,i}$ net calorific value of constituent i of the packaging.

Combustible packaging may contain non-combustible materials, of inert or reactive nature, that may have a negative effect on the calorific gain. H_a for a packaging material may be calculated according to Equation (3) :

$$H_a = \sum_{j=1}^{m} g_j C_{p,j} . (T_a - T_o) \quad (3)$$

where

H_a energy required to adiabatically heat combustion products, residues and excess air from T_o to T_a ;