

## OCCUPATIONAL HEALTH PROBLEMS ASSOCIATED WITH INCREASED RECYCLING OF HOUSEHOLD WASTE\*

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**Abstract:** Since the mid-eighties, Denmark has experienced many and serious working environment problems related to recycling activities. The many activities initiated in order to increase the level of recycling in Denmark, especially on household waste, proved to have many adverse effects on the health of workers collecting and sorting the waste. The problems derive primarily from microbiological factors and the work load (ergonomics). The answer to these problems is integrated planning, taking the working environment and external environment into account at the same time.

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### INTRODUCTION

In recent years, many activities have been directed against increasing the recycling of refuse, in order to reduce the overall amount of waste. Like many countries throughout the western world, Denmark has a high recycling goal: 50% of the garbage should be recycled at the turn of the century.

Since the mid-eighties, Denmark has worked hard to increase the amount of recycling, but, unfortunately, experienced many and serious working environment problems related to recycling activities. The many activities performed in order to increase the level of recycling in Denmark, especially on household waste, have thus proved to give rise to many adverse effects on the workers collecting and sorting the waste to be recycled.

In this historical overview, the Danish experience will be shortly presented in order to outline the reasoning behind the Danish policy regarding research and regulation.

### WASTE SORTING PLANTS

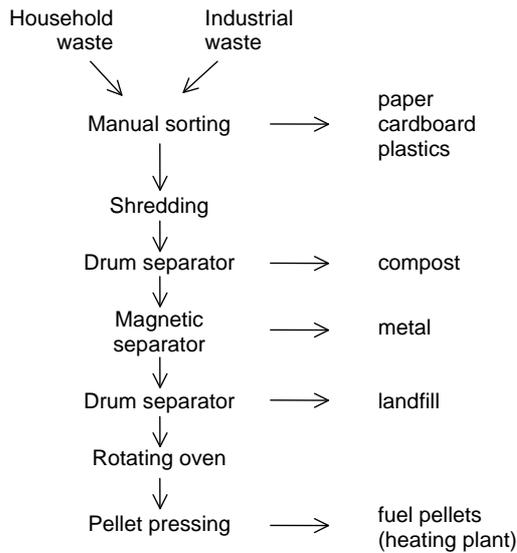
The results summarized focus on the recycling of materials derived from household waste, or waste of a similar composition. The recyclable materials from households are paper and cardboard, metal, organic fraction, and maybe in the future also plastics. The organic fraction is in Denmark often called "the green fraction", and it is collected for composting or biogas formation.

In recent years the problems relating to sorting of garbage in Denmark were first described at a plant performing mechanical and manual sorting of mixed industrial and household waste, a so called MWPF-plant (Fig. 1). This plant, which was designed for maximum recycling, was built in the spring of 1986, and was considered to be the most modern of its type in Europe. Often the wish to obtain very high percentages in recycled material leads to building of these MWPFs. According to the Danish experience, however, these plants may also be potentially harmful to the workers.

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**Figure 1.** Diagram showing processing of waste in the Danish 4S recycling plant (a MWPF facility). The total capacity was 10,000 ton/year and there were 20 employees of which 15 were exposed to organic dust from the waste. (Adapted from ref. 1 and 8).

Only three months after the opening of the plant, the first case of occupational illness appeared, and until the summer of 1991, 10 cases of occupational illness have been registered, in spite of the fact that the group of workers exposed to organic dust consisted of only 15 people. The initial symptoms were upper airway symptoms and Monday fever, and the final diagnosis were eight cases of bronchial asthma, one case of chronic bronchitis and one case of allergic alveolitis [5, 7, 8].

These findings gave rise to a hectic debate in Denmark, and many discussions as to the reason for these problems. In short, the following conclusions were drawn by the Danish Working Environment Service (DWES) [1]:

- The problems were associated with microbial activity. This was due to contamination with food residues of the material to be sorted or otherwise manipulated.
- The symptoms arose very shortly after beginning of the exposure, and a very large group of the exposed workers developed symptoms.
- Many improvements and preventive measures had to be made at the plant. The generation of aerosols had to be minimized, the ventilation system should be improved, filters had to be installed on the trucks, and a cleaning system based on vacuum cleaners was mounted.
- The working routines had to be improved. Safety and maintenance instructions were prepared, and training programs emphasizing the need for hygienic measures were carried out.

In order to evaluate the situation in Denmark, the DWES initiated a study on eight sorting plants and four composting plants [3, 9]. This study led to the following conclusions:

- Occupational health problems are a general risk associated with these activities, and the garbage recycling workers were susceptible to problems with the skin, airway and eye irritation, and gastrointestinal diseases.
- Many more “classical” problems like ergonomical problems, noise and vibrations and exposures to draught and cold were also observed.

These experiences led to a significantly increased co-operation between the DWES and the Danish Environmental Protection Agency (EPA). It was concluded, that future materials recovery systems in Denmark should be based on separation at the source, i.e., at the producer of the garbage.

The experience and recommendations relating to the problems in the working environment at waste sorting centers have been published in a booklet [2]. This booklet contains information on the most serious problems found, how they arise, and how they can be taken into account in the planning phase as well as in the daily operation of the plants.

## COLLECTION OF WASTE

After enforcing the principle of source separation of waste, the next problems arose in the collection of the garbage. In Denmark the waste is traditionally collected at the producers' doorstep, and the waste collector usually delivers the bins or a waste sack at the refuse collection truck, usually equipped with a compactor device, and the garbage is then transported to incineration or to landfills.

The above mentioned source separation of the garbage gave rise to new problems in the working environment, especially regarding collection of the organic fraction.

Very quickly, and for three consecutive summer seasons, many of the workers collecting the organic fraction reported symptoms such as diarrhoea, vomiting, nausea, fatigue, headache and general indisposition. The DWES organized an enquiry, and out of 26 workers reporting to the DWES, 11 reported symptoms, primarily during the summertime [4].

Again, the situation was analyzed and it was concluded that the symptoms were attributed to microorganisms, primarily bacteria and fungi, growing in the waste. The growth is enhanced during the hot season, and the amount of fluid in the containers, in Denmark often called percolate, increases in the summertime.

Again, technical measures to minimize aerosol formation and a change in working routines to improve the level of hygiene had to be enforced.

Besides the problems already described, collection of waste gives rise to accidents and problems related to work physiology. Some qualitative impressions on the health problems from the DWES-Registry of Occupational Accidents and Diseases, indicates that garbage collectors currently have high incidence rates of work related accidents and musculoskeletal problems. Also the

**Table 1.** Overview of the administrative and research objectives of the Danish Working Environment Service Program "Program Concerning Health Problems and Their Solution in Relation to the Government's Action Plan for Waste and Recycling 1993-97". For details on the research part, the reader is referred to the overview by Midtgård and Poulsen [6].

<b>The Danish Working Environment Service Program</b>
Administration
<ul style="list-style-type: none"> <li>• Guidelines, rules and regulations for collection systems, 2-stream and 4-stream systems.</li> <li>• Guidelines and regulations for waste treatment plants.</li> <li>• Instructions of the local authorities.</li> <li>• Establishment of values of acceptance.</li> </ul>
Research
<ul style="list-style-type: none"> <li>• New and standardized methods for measuring and evaluating the most important exposures, primarily microbiological and ergonomic.</li> <li>• Establishment of dose-response relationships.</li> </ul>

occurrence of pulmonary problems, gastrointestinal symptoms and skin problems may be elevated compared with the entire work force. It is the impression that these findings are found all over where garbage is collected in this manner.

### CONCLUSION

The conclusions made by the DWES in 1992, leading to the research program described elsewhere in these proceedings [6] can be summarized as follows:

- These problems have to be dealt with in a systematic approach, otherwise solutions made at one step from collection to recycling can cause problems in the next step.
- There is a great need for flexibility. There are 275 municipalities in Denmark, and it is necessary to give every one of them sufficient knowledge to create local solutions based on the existing systems.
- There is a great need for engineering standards. The solutions up till that time were made case by case, but there is an urgent need for standards to design future systems, optimizing the working conditions without compromising the economical basis for the recycling systems.

On the basis of the above mentioned reflections, it was decided to design a research program to produce values of acceptance for the key parameters, primarily microbial

and work physiological parameters. At the same time it was the ambition to develop measuring methods, which can be used on a routine basis in the exposure assessment and evaluation of the performance of the new systems.

However, more basic work is needed in the coming years. To cope with the problems raised by the aim of recycling 50% of the garbage by the turn of the century, and still being able to design systems taking local (human, economical, historical etc.) aspects into consideration, we find it necessary to give more elaborated standards about the performance of the systems.

We have therefore established a 5-year program ending in 1997, with the aim to produce the necessary knowledge to give information on dose-response relationship concerning the most important parameters. As shown in Table 1, the program has both an administrative part and a research part which are closely coordinated.

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