Cleaner Technology Solutions in the Life Cycle of Concrete Products (TESCOP)

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1. ABSTRACT

The main industrial objective of TESCOP is to develop cost-effective cleaner technologies to fulfil environmental requirements in the concrete industry and to reduce the environmental impact of the concrete products.

The results of TESCOP are 14 developed cleaner technologies in the life cycle of concrete products and a methodology for the selection of areas to develope cleaner technologies.

The methodology consists of a software programme to carry out LCI, a huge amount of environmental data on concrete products, political scenarios regarding priorities of environmental impacts in Europe and in the countries represented in the project and LCI on selected products.

The cleaner technologies represents a broad spectrum of solutions aimed at reducing different environmental impacts such as water consumption, hazardous substances in waste water, working environment, materials resource consumption, energy consumption, substances harmful to health and environment, CO_2 emission and NO_x emission. The cleaner technologies represent solutions in all five life cycle phases, however, with a focus on life cycle phase 2 – concrete production.

2. INTRODUCTION & OBJECTIVES

2.1. Background

The protection of the environment has become a major issue in a global context. This is among others reflected in The Green Agenda from the Rio Conference in 1992 and in the agreements from the Kyoto Conference in 1997.

The EU, national governments and consumers set up environmental requirements to all types of industries. The concrete industry has to fulfil the requirements by environmental taxes or by voluntary agreements to get rid of taxes, too. This will happen through the development and adoption of the most appropriate and economically feasible technologies and techniques for achieving environmental targets based on effective and clean technology.

Concrete is globally one of the most important building materials. Annually, approximately 5 km^3 is used for construction worldwide. The environmental impact caused by the concrete industry is supposed not to be heavy per functional unit but even small improvements will have huge effects because of the big production volume.

In TESCOP the whole life cycle of concrete is considered from extraction and processing of raw materials for concrete manufacturing, construction and rebuilding/extension of buildings and constructions, operation and maintenance of buildings and constructions to demolition and waste treatment/recycling. Aspects related to heating and electricity consumption of buildings are not considered.

2.2. Objectives
The main industrial objective of TESCOP is to develop cost-effective cleaner technologies to fulfil environmental requirements in the concrete industry and reduce the environmental impact of the concrete products.

3. PROGRESS AND ACHIEVEMENTS
TESCOP was completed by 31st August 2000. The results are as follows:
- A methodology, i.e. LCIs and political scenarios.
- 14 cleaner technologies.

The achievements for the TESCOP partners and the concrete industry are as follows:
- A basis for an improved competitiveness caused by economy savings and an improved environmental profile through the developed cleaner technologies
- An increased awareness of environmental issues
- A comprehensive catalogue (the largest in Europe) of environmental data and LCI results for concrete products
- An increased focus on the effect of carbonation (CO_2-uptake) of concrete products in LCIs

The general achievements are:
- A new method for environmental evaluation which combines LCI and environmental political scenarios
- Overview of environmental political scenarios, i.e. priorities of environmental issues
- Exemplification of the sensitivity of LCI to e.g. the quality and the accessibility of input data and whether or not a raw material is considered to be a residual product

The achievement for the Society is:
- A basis for reductions of environmental impacts such as energy, CO_2-emissions and waste, through the implementation of the developed cleaner technologies in the concrete industry.

3.1. Approach
In order to determine the areas where the effect of cleaner technologies is largest, the following methodology has been used. From the life cycle inventories (LCI) an overview of the environmental profile of selected concrete products is made. This overview shows where in the life cycle the largest environmental impacts are, which is also where the effect of cleaner technologies is largest. However, as the LCI includes many environmental impacts, which are not unified/added, it was necessary to make selected environmental impacts a priority in order to limit the development of cleaner technologies. This is done from political scenarios, i.e. priorities of environmental impacts.

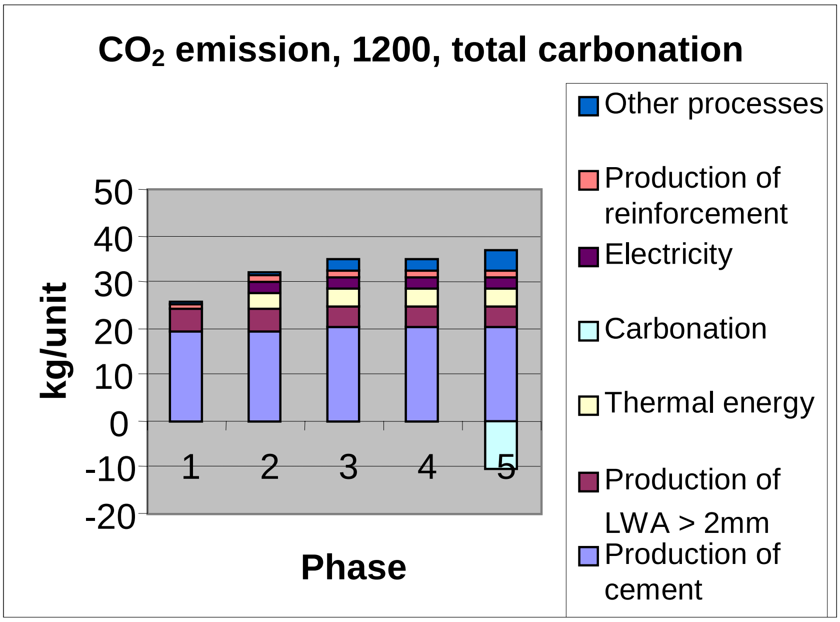
3.2. Political scenarios

The political scenarios was divided into groups of high priority, medium priority and low priority for Denmark, The Netherlands, Italy, Greece and the European Union and International. In the table below is shown the high priority environmental political scenarios.

Countries	Denmark	The Netherlands	Italy	Greece	European Union	International
High priority	- CO_2 - Resource (water) - Fossil fuel (oil) - Substances harmful to health or environment (chemicals, heavy metals)	- Resource (energy) - CO_2 Secondary materials/ resources/ land use/ recycling	- CO_2 - NO_X - Waste	- Resource (Energy)	- Substances harmful to health or environment (toxic chemicals, heavy metals) - CO_2, CH_4, N_2O - Resource (water)	- CO_2 - Resource (water)

3.3. LCI

An example of a LCI result is shown in the figure below. The figure shows the accumulated CO_2 emission for a lightweight wall element in all five life cycle phases. The predominating origin of CO_2 is the cement production. The main reasons for this are the burning of fuel for producing clinker and the CO_2 emission from the calcination of the limestone. The latter can be subtracted when total carbonation of the concrete is assumed. This is illustrated with the negative CO_2 contribution in life cycle phase 5.



The LCI cover one of the most comprehensive catalogues of LCIs of concrete products. In Europe the collection gives a good idea of which processes and raw materials contribute with the highest or lowest impacts.

LCI can be a useful tool for evaluating concrete products. However the results need to be carefully interpreted, as they are influenced by a number of different assumptions and conditions such as:

- Whether or not a raw material is considered to be a residual product. By convention, the environmental impacts of residual products are considered to be nil as the impact is assigned to the primary product.
- The quality and the accessibility of the input data.
- Whether or not carbonation should be included. The concrete will eventually reabsorb the same amount of CO2 that was originally released from the calcination over a period of time, depending on the physical characteristics of the concrete.

3.4. Cleaner technologies

The areas in which cleaner technologies are developed can be seen in the table below. The life cycle phases in which the cleaner technologies have been developed is mentioned in the table. Finally, the environmental impacts, which will be reduced by implementing the developed cleaner technologies, are described.

Cleaner Technology	**Phase in the life cycle of concrete products**	**Environmental impact to be reduced**
Recycling water for use in concrete element production	2	Water consumption Hazardous substances in waste water
Self compacting concrete	2 + 3	Working environment Material resource consumption
Industrialised construction process	3	Material resource consumption Waste Working environment
Steel and concrete	1 + 3	Material resource consumption
Belite rich clinker	1	CO_2 emission NO_x emission
Light weight aggregate from waste	1 + 4	Energy
Planning building components for demolition	5	Waste
Energy saving in concrete production plant	2	Energy
Ready mix concrete logistics	2	Material resource consumption Waste
Water recycling tanks plant	2	Water Material resource consumption
Modular photo voltaic systems for in situ energy supply	3	Energy
Chemicals in admixtures and repair materials	2 + 4	Substances harmful for health and environment
Separate grinding systems	1	Waste Energy Material resource consumption
Direct use of waste in concrete	2	Waste Material resource consumption

The cleaner technologies represents a broad spectrum of solutions aimed at reducing different environmental impacts such as water consumption, hazardous substances in waste water, working environment, materials resource consumption, energy consumption, substances harmful to health and environment, CO_2 emission and NO_x emission. The cleaner technologies represent solutions in all five life cycle phases, however, with a focus on life cycle phase 2 – concrete production.

There is also difference in the solutions with regard to how far the cleaner technologies have reached in the development and implementation process. Several of the cleaner technologies are implemented in the production, some of the cleaner technologies have been trial tested while some cleaner technologies need either to be implemented or to be redeveloped.

In general, the cleaner technology development is successful and apart from the obvious benefits for the concrete industry that can implement the cleaner technologies, the environment will benefit from the solutions, too.

4. CONCLUSIONS

In general the objectives are fulfilled and the developed cleaner technologies constitute important information about how to reduce the environmental impacts in the concrete industry even though the approach was somehow different from the intentions. Apart from the cleaner technologies, the methodology used for selecting cleaner technologies development is a result of TESCOP and so are the side results from the use of the methodology, i.e. environmental data, LCI model, LCI results, and political scenarios.