CHALMERS

*Masters Thesis in association with Södra Cell AB*

# Oil absorptive fiber granules – a new product for Södra?

Industry and Market Analysis of the Swedish Absorbent Market

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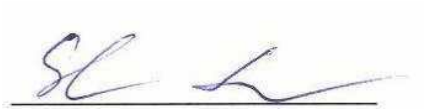

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# Abstract

Oil is a necessity for today's society in the modern world. Due to operational activities it sometimes occurs accidents involving oil spills. There are many sanitation methods that are used to combat oil spill accidents and the most suitable method depends on the situation. Absorbents are a sanitation method which is used to target small oil spills through absorption of the oil. Södra, a wood-processing company, is currently developing an organic absorbent from paper pulp. Södra wants to examine the Swedish absorbent market regarding its competitors, customers and potential. The investigation of the market provides a foundation for the decision making process regarding if the product is suited for further development. In the thesis, A SWOT analysis is used as the framework in order to show a comprehensive overview of both the absorbent market and important product related factors. The environmental effects of Södras and its competitor's products have been included in the SWOT analysis used in the thesis. A qualitative methodology consisting of interviews was conducted in order to gather sufficient data for the analysis. The conclusions from the findings could be summarized as following:

The absorbent market is a mature market that consists of many different market segments. The customers are situated all over Sweden and they do not purchase large volumes of absorbents. The competitors in the industry have very similar products and are small in size and most of them have a turnover ranging from 1-3 MSEK/year and 1-3 employees. The absorbent industry could be a small part of Södras business since the market is not very lucrative and mainly consists of customers with a low usage of absorbents. It could be possible to produce the absorbents in occasional campaigns and/or emergency situations and the surplus of absorbents could be stored for a long time.

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# 1 Introduction

*The background of the thesis and a short introduction to absorbents are described in this chapter. This is followed by a description of the purpose and the research question that are to be answered. Finally, the delimitations in the scope and the structure of the report are described.*

## 1.1 Background

Major oil spills attract the attention of the public and the media. In recent years this attention has created a global awareness of the risks of the oil spills and the damage they do to the environment. However, oil is a necessity for today's society in the modern world. The transport of petroleum from the oil fields to the consumer involves many different transportations systems including tankers, trucks, pipelines and railways. The oil is stored at different storage points along the route and accidents involving oil spills can and does often occur during these transportation steps and storage points. Another common source of oil spills is breakdown and leakage of machinery equipment in the manufacturing industry. [1]

The methods in order to clean up oil are categorized into four different approaches; mechanical recovery, absorbents, chemical and biological treatments agents and *in situ burning*[2] [3]. The most suitable method for cleaning up oil depends on the extent of the oil pollution, the behavoir of the oil, the oil type, and environmental conditions. [4] [5] Oil absorbents are a common method used for sanitation of oil pollution and it is often used as a complement with other methods. Absorbents are characterized as *hydrophobic*[6] materials with a high specific area that effectively absorbs oil. There is a wide variety of oil absorbents that are often divided into three categories; organic, inorganic absorbents and synthetic absorbents[7]. [8]

[1] Nordvik, 2005
[2] Appendix A, Terminology
[3] See chapter 5.6 for more information regarding cleanup equipment
[4] Nordvik, 2005
[5] Appendix B, The behavior of oil in water
[6] Appendix A, Terminology
[7] See chapter 4 for more information regarding absorbents
[8] Interview with Jonas Fejes, IVL Institute, 2008-01-18

Södra, a wood-processing company, is currently developing an organic absorbent from paper pulp. This absorbent is processed from cellulose and does not use any addition of hydrophobic agents in order to make it more environmental friendly than similar absorbents that uses additives. The processing takes advantage of the chemicals in the wood and it is in this way possible to avoid any extra addition of chemicals. [9]

## 1.2 Purpose

Södra wants to examine the absorbent market regarding its competitors, customers and potential. The purpose of the thesis is to investigate how competitive Södras product is compared to similar products, evaluate costs and profitability related to the product and to analyze the customer's usages and values of absorbents. The investigation provides a foundation for the decision making process regarding if the product is suited for further development.

## 1.3 Research question

From the discussion above our research questions are:

- What does the absorbent market look like today regarding its competitors and customers?
- How competitive is Södras product regarding its performance and environmental effects?
- What could cost and eventual profitability be estimated to be?

## 1.5 Targeted readers

This report is intended to be used by Södra as an initial study of the products potential and could be used as a foundation for the decision making process regarding the products future. Researchers interested in methodology that comprises both market analysis and life cycle assessment could also benefit from this report from a methodological point of view.

[9] SINTEF, 1993

## 1.6 Scope

The geographical boundary of this study is limited to Sweden, and especially focuses oil-intense geographical areas such as coastline regions. Sweden has been chosen since Södra is operational in Sweden. Other geographical areas such as Russia or the Baltic states could also be interesting to study but the since Södra was interested into a revision of Sweden, Sweden was chosen as a geographical boundary. However, a small study of the similarities between Sweden and Norway has been conducted since Södra is also operational in Norway. The studied segments include harbours, refinieries, oil depots, shipping companies and other organizations that deal with oil and oil spills near the coast[10]. Regarding the competitors the thesis focuses on close competitors such as organic and inorganic absorbents in the shape of granular and booms. The thesis does not include a study of synthetic absorbents since they usually exists only as carpets and pads and are consequently not a close competitor.

## 1.7 Structure of the report

This disposition describes a brief introduction to each chapter in order to guide the reader troughout the thesis.

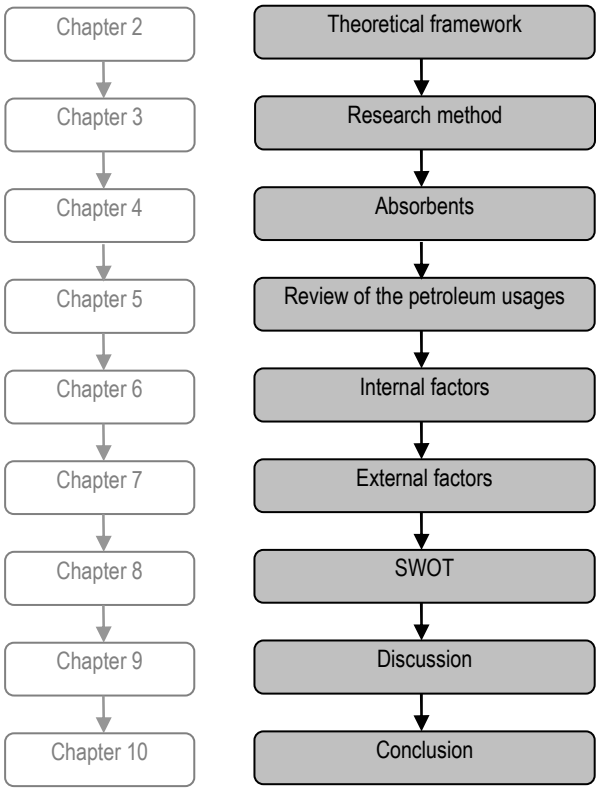


**Figure 1 Structure of the report**

In chapter 2, the *theoretical framework*, which is used in the thesis, is described. The framework consists of strategic tools regarding how the analysis should be constructed. This chapter also consists of theoretical concepts which are used in the analysis.

Chapter 3, *Research method*, describes how the investigation in the thesis is conducted. It also discusses trustworthiness and authenticity of the thesis.

Chapter 4, *Absorbents*, includes a technical description of absorbents, different types and properties of absorbents and technical information regarding Södras product.

Chapter 5, *Review of the petroleum usages*, introduces the link between the petroleum- and absorbent market. This chapter also describes an overview of the petroleum distribution, reported oil spills in Sweden, different oil types, clean up methods and responsibility conditions.

Chapter 6, *Internal factors*, specifically describes the product performance, internal resources and capabilities of Södra, a contribution margin calculation and the environmental effects of Södras absorbent.

Chapter 7, *External factors*, consists of the analysis regarding the external conditions regarding the customers, competitors, environmental effects of the competitor's absorbents. This chapter also includes a review of the absorbent market.

Chapter 8, *SWOT*, is the result of the conducted analysis and aggregates the results from the external and internal analysis into this output. The chapter also contains a description of the included results.

Chapter 9, *Discussion*, discusses recommendations made by the authors, differences and similarities across different segments, a study of the differences and similarities between Sweden and Norway and a critical review of the framework.

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[10] See chapter 7.1.2 for the selection of interviewed organizations

In chapter 10, *Conclusion*, the research questions are answered. The chapter also gives suggestions for further research.

# 2 Theoretical framework

*The theoretical framework consists of two frameworks that are integrated in each other. The market analysis is based upon a SWOT analysis integrated with an analysis of environmental effects. The analysis regarding the environmental effects is based upon a simplified LCA analysis. Finally, relevant theoretical concepts are brought up.*

## 2.1 Structure of the SWOT

There are many various frameworks and approaches used to analyze a business unit or a company's position. One of the most straightforward approaches is the SWOT analysis whereas the term SWOT is the acronym for "strengths, weaknesses, opportunities and threats". SWOT analysis is used as a strategic planning tool to evaluate the strengths, weaknesses, opportunities and threats in a project, product or business venture.[11] In the thesis the SWOT analysis is used to analyze a product regarding its performance, capabilities and also the products' market.

Another common model is the Porter Five Forces model, which include competitors, customers, new entrants, suppliers and substitutes. Porter elaborates on the threat dimension in the SWOT and other perspectives such as the internal is not included. Critics have argued that the industry environment alone does not explain the profitability of the company. A series of studies measuring the profitability between companies has showed that in reality the company's industry environment is a relatively minor determinant of the company's profitability. [12] In the thesis, SWOT is used as a framework since it shows a comprehensive overview of both industry related effects and firm specific effects. [13] The product that is analyzed in the thesis is currently not an existing product and SWOT analysis is often used analyze existing products or ventures. The authors of the thesis thought that the SWOT could be useful as a tool in order to identify the strengths, weaknesses, opportunities and threats of the product.

[11] Aaker: Chapter 1, 2005
[12] Grant: Chapter 4, 2005
[13] Aaker: Chapter 2, 2005

An external and an internal perspective of the organization provide the input to the SWOT analysis. A matrix is used to create a fit between the two perspectives. The SWOT matrix is intended to give a comprehensive and easy overview of the identified strengths, weaknesses, opportunities and threats of the business opportunity. For the business, it is important to build on their strengths, identify their weaknesses and protect against internal vulnerabilities and external threats. [14] The external perspective in the thesis is divided into four components; customer analysis, competitor analysis, market analysis and an environmental effects analysis. The internal perspective aims to provide a detailed understanding of strategically important aspects of the organization[15]. In particular, it covers performance analysis and strategic resources and capabilities.

Critics against the use of SWOT view it as a generator of long lists of factors, general and often meaningless descriptions. [16] There is therefore a need to assign the most important factors and describe them in more detail.

The thesis aims to evaluate the environmental effects of the product and its competitor's products. The foundation for the analysis of the environmental effects is found in the LCA framework, which is a tool used to analyse the environmental effects of a product or a process. Since the SWOT does not include this perspective this component is added to the SWOT in the thesis. The environmental effects are studied both in the internal and external perspective since it covers both Södras and its competitors products.

## 2.2 Life Cycle Assessment

Life Cycle Assessment (LCA) is a tool for assessing the environmental impacts associated with a product, process or service throughout its life cycle. The term life cycle refers to the major activities in the course of the product's life span from its manufacturing, usage, and maintenance, to its final disposal including the acquisition of raw material required to manufacture the product. Figure 2 illustrates the possible life cycle stages that often are considered in an LCA and the typical measured inputs and outputs. [17]

[14] Aaker: Chapter 1, 2005
[15] Aaker: Chapter 2, 2005
[16] Hill & Westbrook, 1997

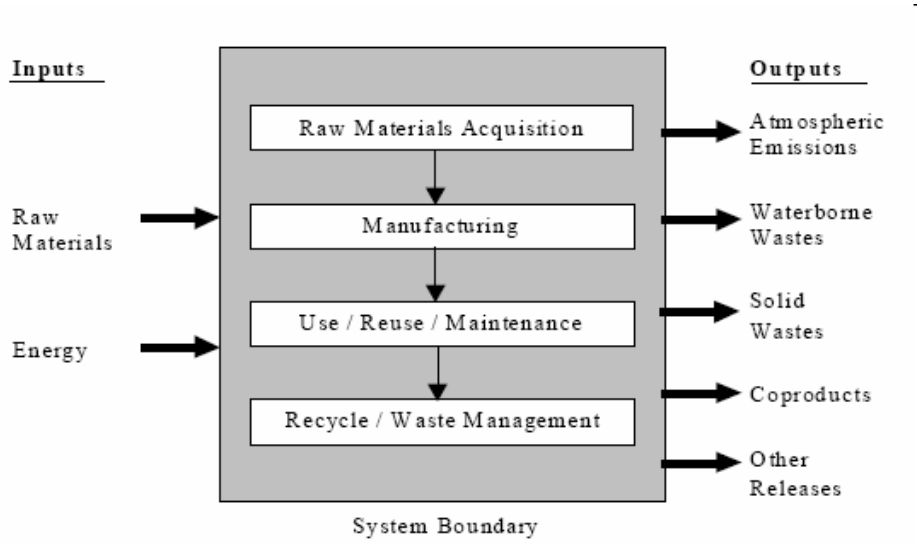


**Figure 2 Life cycle stages [18]**

The thesis uses a simplified version of the LCA analysis provided by Jonas Fejes and Erik Lindblom, which is specifically suited for absorbents. This version includes the following components; manufacturing, absorption capacity, usage and the destruction of the absorbents[19]. The energy consumption of the manufacturing is not included in their tool which often is considered in the LCA. Absorption capacity is a component specifically designed for absorbents that is important since the amount of absorbents needed on oil spills are very dependant on the effectiveness of the product. A product with low efficiency demands larger quantities of absorbents, which result in a higher environmental impact. [20]

Furthermore, Fejes and Lindblooms tool has been been modified in the thesis. In order to implement the analysis of both Södras product and its competitors some of the components in their tool have been excluded. Furthermore, the dimension considering the usage is complemented with other relevant technical factors of the absorbents that are regarded as important by a report from SFT and other studies by Fejes. [21] [22] [23]

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[17] Curran, 2006

[18] Curran, 2006

[19] A detailed description regarding Fejes and Lindbloms framework is included in Appendix C

[20] Fejes & Lindblom, 2003

[21] Fejes et al, 1999

[22] Løset, 1993

[23] See Appendix C for a detailed description of the original method and the modification

## 2.3 Theoretical concepts

Important theoretical concepts that are crucial for the understanding of the analysis are presented in this chapter. The theory in this chapter is used to support the analysis in the internal- and external factors and in the SWOT.

### 2.3.1 The buying behaviour process

The consumer decision making process is essentially a problem-solving process. Most customers, whether individual consumers or organizational buyers, go through a similar mental processes in deciding which products and brands to buy. The relative importance of the purchase decision will reflect the consumers' need for information. [24]

*High-involvement* purchases involve goods or services that are psychologically important to the buyer and carry social and psychological risks. They may also involve a lot of money and therefore financial risk. This purchasing process is complex since there is a large need for information. [25]

*Low-involvement* purchases are not very important to consumers'; the search for information to evaluate alternative brands is likely to be minimal. The consumers' involvement and their risks associated with making poor decisions are low for such products. Therefore consumers are less likely to stay with the same brand over time since they have little to lose by switching brands. [26]

### 2.3.2 Entry barriers

Barriers to entry are obstacles in the path of a firm which wants to enter a given market. If an industry earns a return on capital in excess of its cost of capital, that industry acts as a magnet to firms outside the industry. The absence of entry or exit barriers will cause the rate of profit to fall towards its competitive level regardless of the number of firms within the industry. The principal sources of barriers to entry are capital requirements, economics of scale, cost

[24] Mullins et al: Chapter 5, 2005
[25] Mullins et al: Chapter 5, 2005
[26] Mullins et al: Chapter 5, 2005

advantages, product differentiation, access to channels of distribution and governmental and legal barriers. [27]

### 2.3.3 Brand equity

Brand names and other trademarks are a form of reputational asset: their value is the confidence they instill in customers. This value is reflected in the price premium that customers are willing to pay for the branded product over that for an unbranded or unknown brand. In a mature industry the established firms posesses an advantage of brand recognition and customer loyalty. Late entrants to the industry often suffer additional advertising and promotional costs. [28]

### 2.3.4 Vertical integration

Vertical integration is the degree to which a firm owns its upstream suppliers and/or downstream buyers and refers to the strategic option that includes integrating forwards or backwards in the *value chain*[29] . Forward integration occurs when a firm moves downstream with respect to product flow, such as a manufacturer buying a retail chain. Backward integration occurs when a firm moves upstream respect to product flow, such as an automobile manufacturer buys a tire company. Vertical integration potentially provides access to supply and demand and entry into an attractive business area. The drawback is however the risks of managing a very different business and the reduction of strategic flexibility. The vertical integration strategy could pose as strategic advantage and an entry barrier for competitors. [30]

### 2.3.5 Core competence

Core competence is an ability that a firm do well, provides customer benefits, is not easy to imitate and can be leveraged into many products and markets. The ability of firms to track and exploit their core competencies depends upon their specific technological and organizational competencies, and on the difficulties that competitors have in imitating them. According to Tidd et al., Hamel and Prahalad describes that the sustainable competitive advantage of firms resides not in their products but in their firm-specific competencies. The real sources of

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[27] Grant: Chapter 3, 2005

[28] Grant: Chapter 5, 2005

[29] Appendix A, Terminology

[30] Aaker: Chapter 13, 2005

advantage are to be found in management's ability to consolidate corporate-wide technologies and production skills into competencies that empower individual businesses to adapt quickly to changing opportunities. [31]

[31] Tidd et al., 2005

# 3 Research method

*This section describes procedure and the sources of information used in the report. The selection of interviewees is explained in this chapter. The trustworthiness and reliability of the collected information and results are also discussed.*

## 3.1 Procedure

The procedure is derived from the SWOT analysis described in the theoretical chapter. Figure 3 describes an overview of the procedure in the thesis.

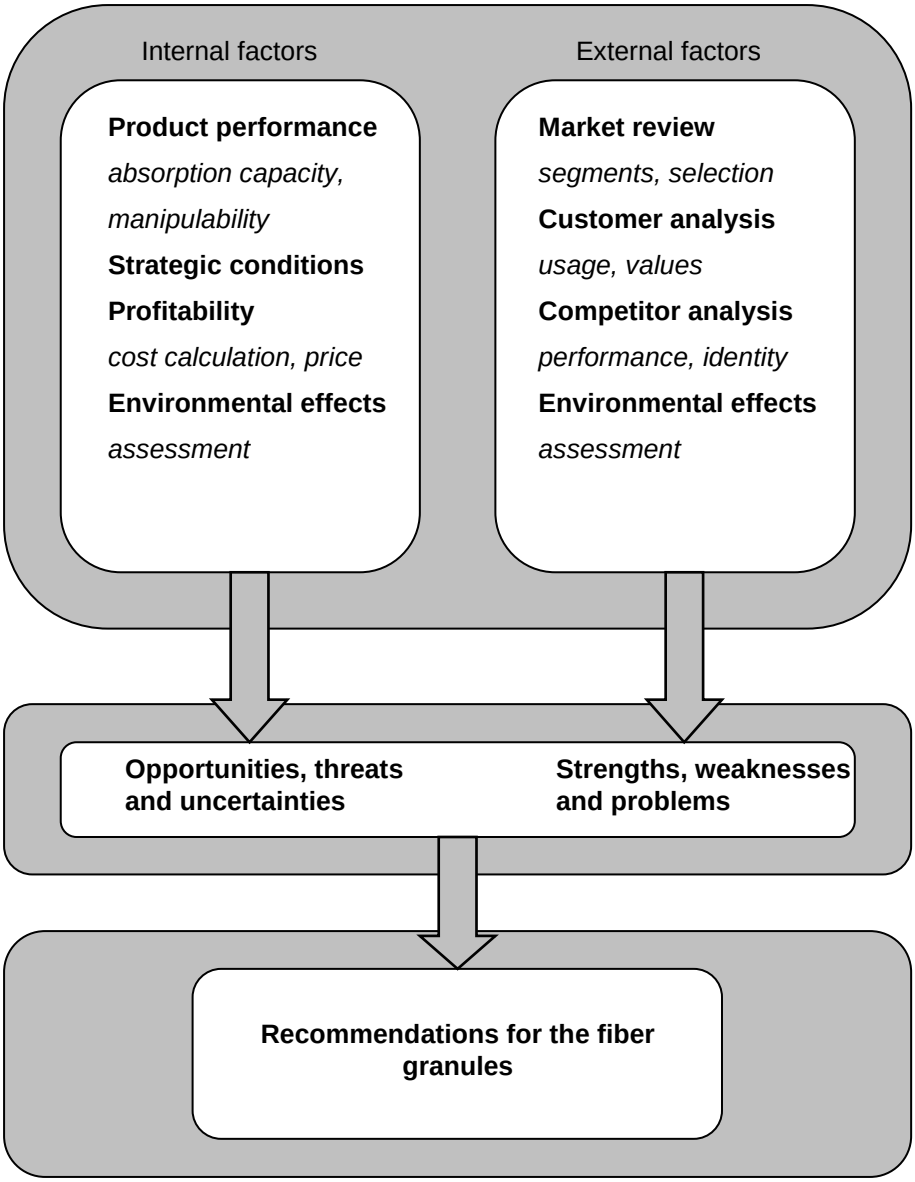



**Figure 3 Basic overview of the SWOT analysis used in the thesis**

***Internal factors***

The section concerning the internal factors describes the *product performance* of Södras' product, *internal resources and capabilities* and a chapter concerning the *profitability* that includes a production cost calculation. Furthermore, the chapter concerning the *environmental effects* describes the environmental effects of Södras product in detail.

***External factors***

The external analysis consists of four chapters; market review, customer analysis, competitor analysis and environmental effects. The *market review* identifies potential segments which have a need for oil sanitation products and methods. The delimitations are described and after that the selected segments and organizations which are interviewed are presented. The *customer analysis* identifies the usage of absorbents of the selected organizations. The chapter also indentifies the customers' needs and values. The *competitor analysis* identifies close competitors, their business and products. Furthermore, the chapter concerning *environmental effects* evaluates the competitors and Södras product regarding their environmental performance.

***SWOT***

The SWOT analysis evaluates the strengths, weaknesses, opportunities and threaths derived from the internal and external analysis. It consists of a matrix, which is the result of the relevant factors which have been studied in the analysis. The factors which are considered in the SWOT are described in detail in this chapter Recommendations made by authors of the thesis regarding the SWOT are described in the discussion.

## 3.2 Data collection

The information gathered in the report is based both from primary and secondary data sources.

*The primary data*, characterized as data which is not found in earlier studies, are gathered from interviews. The thesis uses a qualitative research strategy in the investigation. The qualitative research method is a method which usually faces words rather than quantification of data. The report mainly uses *semi-structured interviews*[32] as a source of data collection in

[32] Appendix A, Terminology

the qualitative research. Interviews are used to investigate the customers' usage and opinion of sanitation methods, needs and values. [33] The qualitative investigation method is generally very flexible and adaptable in the initial structure that makes it suitable for investigations of a more exploring nature. [34] Other primary data sources include interviews with manufacturers and distributors of absorbents, statisticians and researchers.

*The secondary data* used in the report consist of product data sheets, statistical information, information about characteristics of competitors' absorbents, and information about the properties of different oil types. This data has been gathered from scientific databases, literature, websites, samples, instruction manuals, internal material from Södra, industry organizations and technical reports. [35]

## 3.3 Selection of interviewees

The interviewees are chosen from the identified and selected market segments in the market review[36]. The thesis focuses on customer segments that use and/or manage a large amount of petroleum and petroleum products. The advantage of using small segments is to provide an easy and comprehensive overview of the studied segments. The alternative to use large segments would imply a different methodology or studying a very small sample of the segments, which could imply difficultiveness to provide a trustworthy analysis. It would for example be difficult to construct a trustworthy analysis of the forestry segment gathered from a small selection of interviews since it consists of more than 50 000 relatively small companies with a wide-ranging absorbent consumption. The customer segments are identified using sources from articles, competitors, responsibility conditions and statistics regarding managing and usage of petroleum and petroleum products. The identification of the selected customers includes industries that consume large amounts of oil, industries using a lot of machinery equipment, the transport industry and relevant public organizations.

[33] Appendix D – Guidelines for interviews with customers

[34] Svensson & Starrin, 1996

[35] Svensson & Starrin, 1996

[36] See chapter 7.1 for more information regarding the selection of customers

## 3.4 Trustworthiness and authenticity

According to Bryman and Bell, Lincoln and Guba states that trustworthiness and authenticity provides a more appropriate evaluation than validity and reliability in qualitative studies. The qualitative method has a lack of generalization which makes it difficult to know if the findings can be generalized to other settings. For example, it may be difficult to interprete if our results would be the same in another geographical area such as in another country. The qualitative method is also criticized for being skewed since the authors choose the respondents for interviews and make a subjective evaluation from the results. It should be apparent to not allow personal values or theoretical inclinations to influence the conduct of the research. [37] By conducting many interviews with different actors in the industry, using reliable references and a comprehensive literature survey the authors of the report are trying to minimize problems concerning the trustworthiness and authenticity of the study.

[37] Bryman & Bell: Chapter 13, 2003

# 4 Overview of absorbents

*A common method for oil spill cleanup is to use absorbents to collect and separate oil from water. This chapter consists of three parts; types of absorbents, properties of absorbents and technical information regarding Södras product.*

## 4.1 Types of absorbents

Absorbents could be categorized into three groups; organic absorbents, inorganic absorbents and synthetic absorbents. [38] Absorbents exist in many different shapes. The material is often granular but it can be enclosed in various shapes such as absorption booms, pads and socks. Figure 4 displays different kinds of absorbents in the granular shape.

**Figure 4 Different types of absorbent materials in the granular shape (cellulose, bark, minerals) [39]**

*Organic absorbents* are made of materials such as wood, cotton, cork, bark, etc. The organic absorbent are in general cheaper than synthetic absorbents and also has the advantage of biodegradability. However, in general they do not posses as high absorptive capacity as synthetic absorbents. [40]

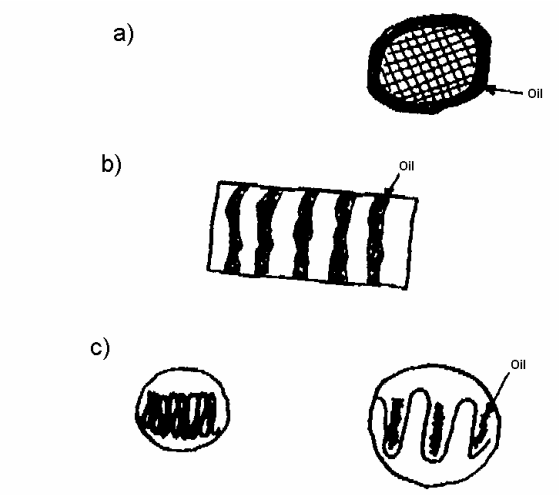
*Inorganic absorbents* are made up of a large range of materials and the most common include pumice, rubber and perlite. Inorganic absorbents are usually cheap but they have several disadvantages. The most common disadvantages are difficulties in managing and application, toxicity and a risk for the absorbent to sink. [41]

[38] Ventikos et al., 2003
[39] Pictures created by the authors of the thesis, 2008-05-05
[40] Fejes, 1993
[41] Fejes, 1993

*Synthetic absorbent* are usually made of polymers whereas polypropylene and polyurethane are the most commonly used commercial absorbents in oil spill cleanup due to their hydrophobic and absorptive capabilities. However, since landfill disposal is environmentally undesirable and incineration is very expensive, the non-biodegradability of these materials is a major disadvantage. [42]

## 4.2 Properties of oil absorbents

Absorbent materials are manufactured to recover oil from water using absorption, adhesion or swelling. Properties that characterize a high quality absorbent include hydrophobic material and high absorptive capacity. The mechanism regarding the absorptive capacity is illustrated by figure 5. In general, the absorptive capacity depends upon pore size, hydrophobicity, the specific surface area and the molecular structure.




**a)** *Adhesion*; the oil is added as a thin film on the surface of the absorbent material.

**b)** *Absorption;* the oil is absorbed into the pores of the absorbent material.

**c)** *Swelling*; the oil is locked into the molecular structure of the absorbent material. As a result the absorbent increases in size. [43]

**Figure 5 Absorption mechanisms** [44]

Many absorbents combine absorption and adhesion mechanisms. When the viscosity of the oil is increasing and/or the temperature is decreasing, the oil will not flow into the interior pores and will mainly stay on the surface by adhesion. Figure 6 shows that adhesion becomes predominant with increasing oil viscosity. Heavy oil types, such as crude oil and fuel oil number 5 and 6, are absorbed mainly using adhesion because of its high viscosity. Lighter oil

[42] Adebajo et al., 2003
[43] SINTEF, 1977
[44] SINTEF, 1977

fractions, such as gasoline and diesel oils, are often absorbed to a larger extent by absorption. [45]

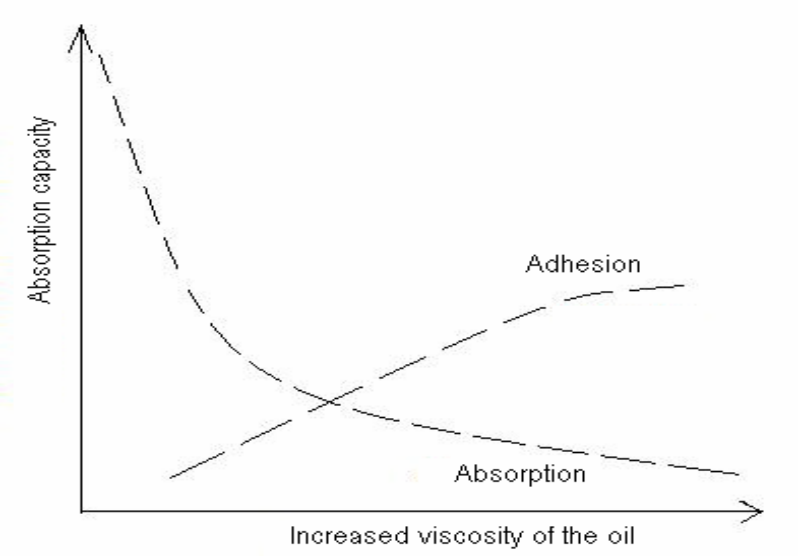



**Figure 6 Absorption mechanism as a function of the viscosity of the oil**

## 4.3 Technical description of Södras product

The fiber granule from Södra is an organic absorbent consisting of mechanical paper pulp (TMP or CTMP). The advantage with TMP or CTMP compared to chemical pulp is that more resins, which are hydrophobic, are preserved during this process. [46] This chapter describes the technical description of the product including the manufacturing process, distribution and storage.

**Manufacturing process**

The *first* step in the manufacturing process is the CTMP (Chemi-Thermomechanical Pulp) process where the raw material of the absorbent is produced. The method for producing the pulp comprises impregnating, preheating and defibration. The impregnation and preheating of the chips are treated in one and the same tank over a period time of most 2 minutes, using a warm impregnating liquid with a temperature of at least 130 °C. The chips are then preheated at a temperature of 150-175 °C. The next step is the defibration process that separates the fibers from the wood and is carried out at temperature of 135 °C. It should however be noted

[45] Løset, 1993

[46] Soteland & Bohmer, 1993

that the TMP process could also be used. TMP is similar to CTMP but does not involve any impregnation of chemicals. [47]

The *second* step is carried out in the rotating dryer where the refined pulp will be dried at a higher temperature than the ordinary pulpmaking process while rotating in a drum and the resins inside the material moves to the surface and forms a hydrophobic layer on the outside of the particles. Particles with an undesirable size will be transferred back to a second drying procedure. [48]

The *third* step involves the packaging where the product is packaged in a semiautomatic machine in order to manage the process more efficiently.

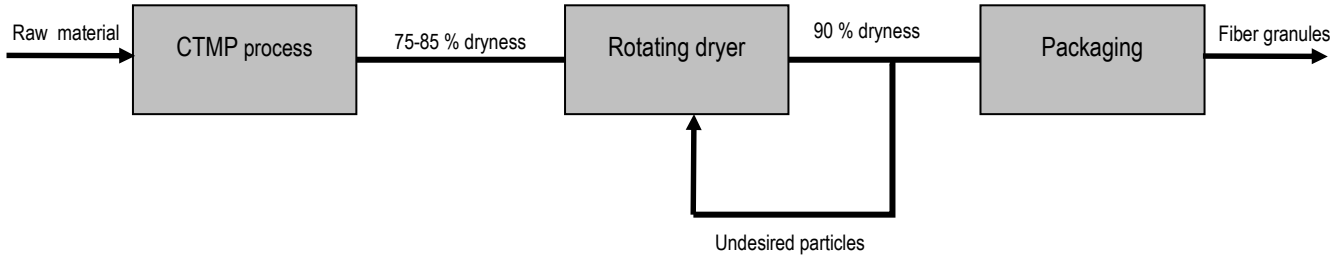



**Figure 7 Manufacturing process**

### Distribution and storage

Since the granules are quite bulky with a large volume in relation to its price the transportation costs could be relatively large[49]. Other manufacturers of absorbent products make the customers pay for the transportation. This method benefits customers which are situated close to the storage facility and could be suitable if the customers buy large volumes. The alternative is to integrate the transportation cost in the price of the product. Since the fiber granules have a dryness level of more than 90% and the particles could be stored for several years[50].

[47] Soteland & Bohmer, 1993
[48] Soteland & Bohmer, 1993
[49] Soteland & Bohmer, 1993
[50] Soteland & Bohmer, 1993

# 5 Review of the petroleum usages

*This chapter describes important information regarding the petroleum usages and its connection with the absorbent market. This chapters include the following sections; An overview of the oil market, petroleum types, usage and distribution, overview of oil spills followed by responsibility conditions and cleanup methods.*

## 5.1 Link between oil- and absorbent market

The petroleum usages are studied since our product is used for the sanitation of petroleum and petroleum products. The absorbent market is thus very dependent on the petroleum market. Therefore it is important to study petroleum oil types, distribution of oil, legislations and other sanitation methods which have high impact on the demand for absorbents.

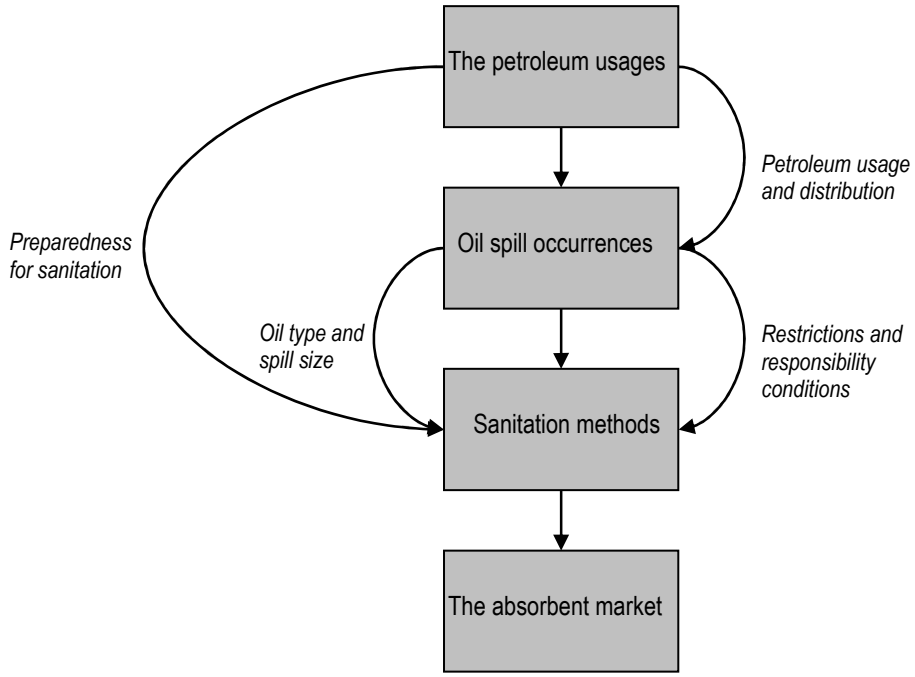



**Figure 8 The link between the oil- and absorbent market**

**Figure 8** illustrates the link between the oil- and absorbent market. The usage and distribution of petroleum involves a risk of the occurrence of oil spill. When oil spills occur, a sanitation method is necessary in order to clean up the polluted area. The chosen sanitation method is dependent upon the oil type and the extension of the spill, the organizations preparedness for sanitation, responsibility conditions and imposed restrictions of the sanitation method. Absorbents are one of many sanitation methods, which is used to a large extent as a sanitation

method for oil spills. The absorbents are often used for small oil spills or as a complement for other methods. [51]

## 5.2 Petroleum types

There are variety of petroleum types with different characteristics. In order to make the thesis more understandable this chapter presents the most common types. Table 1 categorizes different petroleum types in three dimensions; viscosity, pour point and density. The properties for the different types vary but the table serves as a guideline.

**Table 1 Categorization of petroleum types [52]**

| Categorization of petroleum types | Viscosity ( at 0°C) | Pour point | Density ( at 15°C) | Primary use |
|---|---|---|---|---|
| | (cSt) | (°C) | (kg/dm$^3$) | |
| Jet fuel | < 1 | - 50 | 0,77 - 0,85 | aircrafts |
| Gasoline | < 1 | - 40 | 0,74 | automobiles, light trucks |
| Diesel | 4 - 8 | - 35 / - 20 | 0,84 | automobiles, trucks, ships |
| Crude oil | 1 - solid | - 35 / + 25 | 0,75 - 1 | oil refineries |
| Lube oil | 100 - 1 000 | - 50 / - 20 | 0,85 - 1 | hydraulic machinery |
| Heavy fuel oil (4-6) | 600 - solid | - 10 / + 30 | 0,89 - 1 | ships, power plants |

*Viscosity* is used to measure a fluids resistance to being deformed and may be thought of as a measure of fluid friction. A thin fluid, such as water, has a low viscosity (1 cSt) and a thick fluid like syrup has a larger viscosity. The viscosity is highly temperature dependent and the lower the temperature is, the higher viscosity the fluid has, which makes the fluid thicker. High-viscosity oil fractions tend to freeze in low temperatures. [53]

The *pour point* is dependent on the viscosity and describes the lowest temperature a liquid remains pourable (still behaving as a fluid). By further decreasing the temperature the fluid will cease to flow. [54]

*Density* is usually measured at 15°C (SI unit) and describes the ratio of mass of an object compared to its volume. Water has a density of 1 kg/dm$^3$ and oil types that has a lower

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[51] Fejes, 1993

[52] www.indiancoastguard.nic.in, 2008-03-24
Kustbevakningen, 2002

[53] Kustbevakningen, 2002

[54] Kustbevakningen, 2002

density than water will float on the surface. High-density petroleum types, such as asphalt, tend to sink in water. [55]

The petroleum types influence on its behavior in water is studied in detail in Appendix B in order to provide an insight behind the mechanisms of oil transformation processes in water. Most of these mechanisms could also be valid on oil spills which occur on land such as the evaporation and biodegradation process. [56]

## 5.3 Petroleum usage

To give an indication of the Swedish petroleum consumption a table of the balance of resources is shown below. Table 2 consists of the Swedish petroleum import and export, the production and usage in refineries and the inflow (import + production).

| Balance of resources ('000 $m^3$) | Import | Export | Refinery usage | Refinery production | Inflow |
|---|---|---|---|---|---|
| Jet fuel | 1 060 | 20 | 0 | 224 | 1 284 |
| Gasoline | 2 970 | 3 308 | 638 | 6 014 | 8 984 |
| Diesel | 2 241 | 5 104 | 31 | 8 850 | 11 091 |
| Heavy fuel oil | 688 | 3 516 | 28 | 5 723 | 6 411 |
| Other products | 620 | 821 | 0 | 810 | 1 430 |
| Crude oil | 22 490 | 0 | 24 056 | 0 | 22 490 |
| Summation | 30 069 | 12 769 | 24 753 | 21 621 | 51 690 |

**Table 2 Import and export balance 2006** [57]

The Swedish import consists of all petroleum types but crude oil is by far the largest imported petroleum product. The export consists only of refined products since Sweden does not have any domestic oil production. [58]

The inflow of petroleum products serves as an overview of the transportation of petroleum products in Sweden since it shows both the import and the domestic production of petroleum. The more extensive the transportation of petroleum products is the larger is the risk of occurring accidents involving oil spills. About half of the inflow consist of crude oil, which is

55 Kustbevakningen, 2002

56 Appendix B, The behavior of oil in water

57 www.spi.se, 2008-03-25

58 www.spi.se, 2008-03-25

imported mainly trough oil tankers to large ports. These ports are often connected to refineries which convert the crude oil into smaller fractions that are later used in the industry. [59]

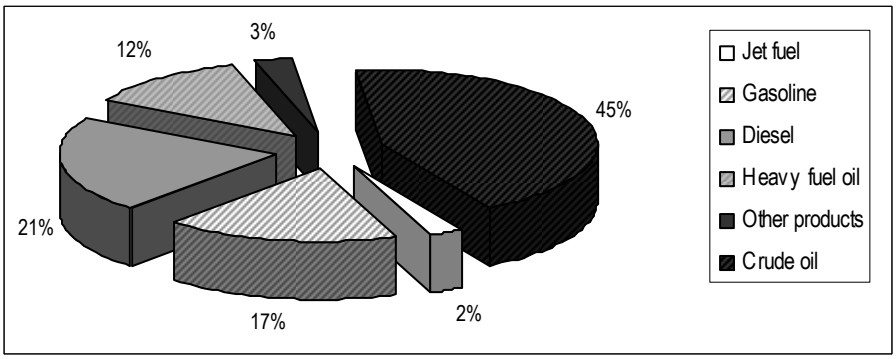


**Figure 9 Inflow of petroleum in Sweden 2006, (000' $m^3$)**

Figure 10 describes the most common distribution channels used for oil vessels in the Baltic Sea. The Baltic Sea is highly trafficked by oil tankers compared to most other marine waters in the world. [60]

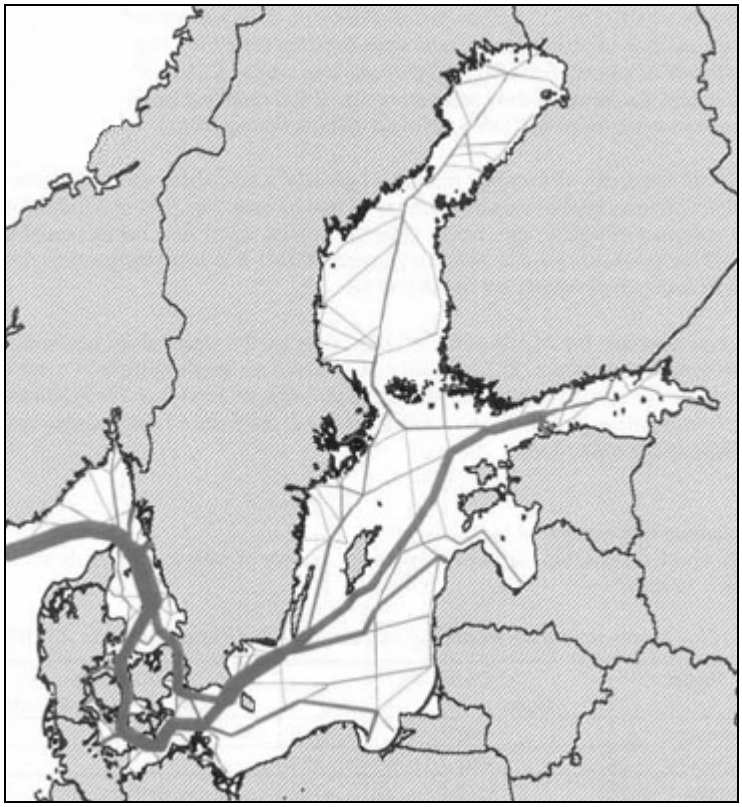

**Figure 10 Sea routes in Sweden [61]**

[59] Greenpeace, 2008

[60] Greenpeace, 2008

[61] Rytkönen et al., 2002

In Sweden, the Kattegat has extensive marine traffic since it act as a transportation channel to the countries surrounding the Baltic Sea. The resulting effect is that the Kattegat has a high risk of being polluted by oil spills and operational discharges. The largest volumes are however transported in the opposite direction, from harbors in the eastern region of the Baltic Sea to destinations around the whole world. Russia, which is the second largest oil producer in the world, freights more than one third of its oil export throughout the Baltic Sea.[62]

## 5.4 Reported spills

According to Christer Lundberg, toxicologist and statistician on *Räddningsverket*[63], about 20% of the number of oil spills occurs in water but it makes up for 80% of the volume. The numbers of reported oil spills are different from the actual numbers of occurrences but can serve as an indicator of how often and where oil spills occur. [64] Illegal discharges which are not discovered by *Kustbevakningen*[65] and small spills that are not reported are not covered by the information in this chapter. It is also important to bear in mind that the figures in this chapter describe the number of occurred spills and not the volume.

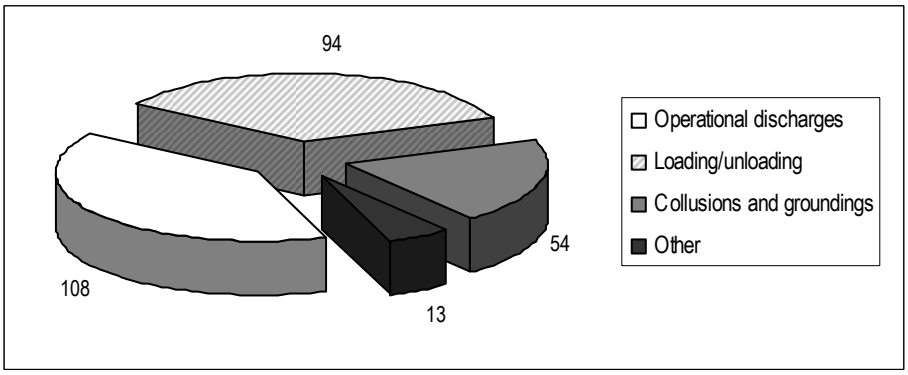


**Figure 11 Number of oil spill occurrences in water**

Kustbevakningen registered 269 confirmed oil spills for 2006, which is a bit lower than most years. The spill registered by Kustbevakningen occurs on the sea and on the larger inland lakes Vänern and Vättern. [66] The actual number of operational discharges accounts for a large number of oil spills on water but are difficult to estimate since they are not reported unless

62 Greenpeace, 2008

63 Räddningsverket is the Swedish word for the agency called Rescue Services Adminstration

64 Interview with Christer Lundberg, Räddningsverket, 2008-03-19

65 Kustbevakningen is the Swedish word for the agency called the Coast Guard

66 www.kustbevakningen.se, 2008-03-20

they are subject to aerial surveillance. Other common sources of oil spills on water include collusions, groundings and loading/unloading of cargo. [67]

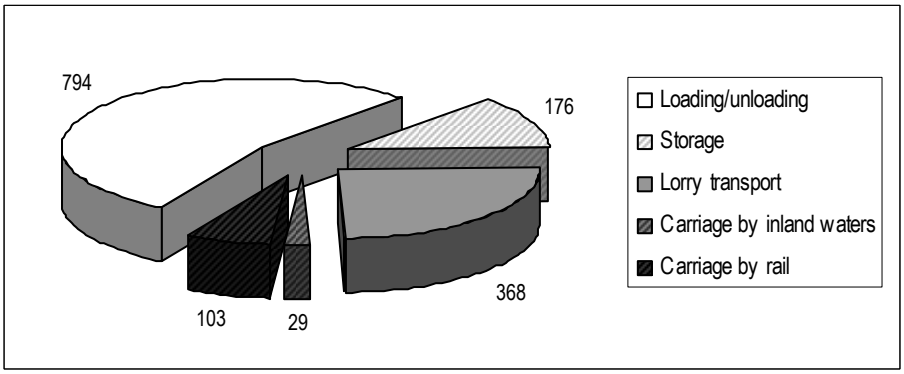


**Figure 12 Number of oil spill occurrences on land**

Räddningsverket registered 1470 oil spills on land for 2006. The most common source for oil spill was loading/unloading of cargo, followed by lorry transport and accidents involving storage of oil. Other sources included accidents involving trains and vessels on inland waters. [68]

### 5.4.1 Responsibility conditions

The actors who are responsible for the cleanup of oil spills usually have a need for sanitation methods and products. Therefore it is interesting to study legislations regarding the responsibility conditions during occurring oil spills.

The responsibility terms are a complex issue when oil spills occur and many actors could be involved. The society's demand for oil spill prevention is dealt with in several sections of the law. Many issues are also targeted in a regional environmental legislation and other problems are not regulated into detail by laws, bylaws and injunctions and thus refer to legal usage.[69]

[67] www.helcom.fi, 2008-03-20

[68] www.raddningsverket.se, 2008-03-20

[69] Forsman, 1997

**Table 3 Crude sketch of the responsibility conditions in Sweden [70]**

| Accident type | Obligations |
|---|---|
| Oil spills on land, harbours and smaller lakes | The communes take operational responsibility responsibility together with Räddningstjänsten |
| Oil spills on seas and larger lakes | Kustbevakningen take operational responsibility responsibility and are sometimes assisted by Sjöfartsverket, the police and the military |

Table 3 represents a crudely drawn sketch of the responsibility conditions in Sweden. Räddningsverket are together with the communes obliged to cleanup oil spills on land, harbors and smaller lakes. The communes are obligated for the sanitation work and the Räddningsverket should as a central authority coordinate efforts between the society's emergency services and the communes and also assist the communes with counseling. However, in reality many companies often clean up their own oil spills. At sea and in the larger lakes, Kustbevakningen has the overall responsibility to cleanup oil spills. When required, Sjöfartsverket, the police and the military services assist in the sanitation efforts. [71]

### 5.4.2 Preparedness

The socitetys demand for oil spills prevention is mentioned in several law sections. Some laws and bylaws are parts of international agreements and directives that Sweden has committed to follow. The communes' are prepared for oil spill accidents which could occur during many different types of activities whose operations could be harmful to the environment. For example, storage and managing of oil is considered to be businesses that are considered to be harmful to the environment. In a facility where the operations imply a danger for accidents involving damage on the environment, the owner of the facility is responsible to a reasonable extent perform and finance preparedness in order to prevent or limit the damages caused by an accident. [72]

Environmental management standards could help to increase the organizations preparedness for accidents involving oil spills. The fundamental requirements for the environmental certificate ISO 14 001 are the documentation of the companies operations and strive for continuous improvement. The environmental management standards exist to help

[70] Sjöfartsverket is the Swedish word for the national Shipping Maritime Organization

[71] Forsman, 2006

[72] Forsman, 1997

organizations reduce their operations negative effects on the environment. [73] [74] The acquirement of absorbents or other sanitation methods could be helpful to implement the strive for continuous improvement in the environmental certificate.

## 5.5 Cleanup equipment and usages

The most effective response method for oil spill cleanup is dependent on the spilled oil type, quantity, location, response time, environmental conditions and the availability and capability of response technologies. [75] The ideal oil spill response strategy should be to optimize the use of all effective response methodologies and technologies available in order to minimize the environmental impact of the oil spill. However, the ability of using multiple or combinations of different response methods effectively in practice is quite limited. [76] This chapter explains different sanitation methods and under what conditions they are optimal. Physical methods such as scraping and gathering of oil are not included in this chapter that focuses on equipment for sanitation.

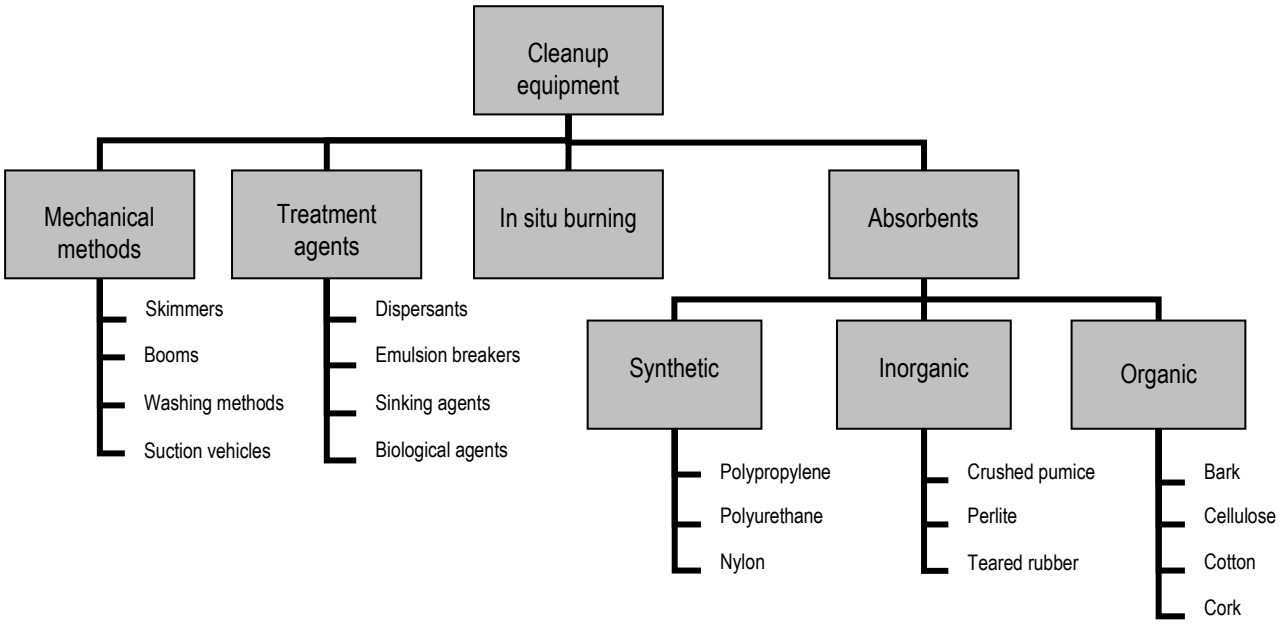


**Figure 13 Common cleanup methods**

[73] www.nutek.se, 2008-03-25

[74] www.stockholmsustainableregion.se, 2008-03-25

[75] Appendix B, The oil behavior in water

[76] Nordvik, 2005

### 5.5.1 Mechanical methods

Mechanical methods are often used to clean up oil spills and these methods include containment and recovery of oil. The most common types of mechanical recovery methods include skimmers and booms that are often used together. Booms are often used on water and float on the surface and act as a fence to keep the oil from spreading or floating away. The booms are connected into sections that are placed around the oil spill until it is completely surrounded and enclosed. Most booms available on the market are not designed for operations under rough weather conditions. Skimmers are remediation devices that are used to remove oil from the water surface. Once the oil is contained using booms, skimmers are used to remove it from the water surface. Skimmers get clogged easily and do not work well on large oil spills or when the water is rough. [77] Other mechanical methods include sludge suction vehicles and washing methods. These methods are often used on land. Washing methods are used with a high pressure to clean up the contaminated area. Slam suction vehicles are used to collect the oil when the oil is enclosed in one area. [78]

### 5.5.2 Treatment agents

A variety of treatment agents are used to take care of oil spills or to function as a complementary method for mechanical oil recovery methods. The main feature of these agents is to change the physical or chemical properties of oil. The most common treatment agent is dispersants, which are surfactant mixtures that reduce the interfacial tension between oil and water and thus breaks the oil into fine droplets that is distributes in the water column. [79] It should be noted that dispersants may cause serious ecological damage. In general, they are applicable in large oil spills. [80] The best application from dispersants and other chemical treatment agents is when the oil spill threatens coastline areas and could inflict serious environmental damage. The use of dispersants should be authorized by Naturvårdsverket and should only be used under very special circumstances[81]. Other common chemical treatment agents include sinking agents and emulsion breakers. Emulsion breakers help to separate oil-in-water emulsions and sinking agents operate by causing the oil to clump together, and then

[77] Nordvik, 2005
[78] Fejes, 1993
[79] Appendix B, The behavior of oil in water
[80] Ventikos et al., 2003
[81] Fejes, 1993

the oil droplets fall to the bottom of the sea. [82] *Biological treatment agents*[83] are used to accelerate the biodegradation of the petroleum or the petroleum products. However, biological treatment agents are not used very often in oil spills and the effectiveness of this method has not been studied in detail. [84]

### 5.5.3 In situ burning

In situ burning refers to the ignition and burning of oil spills and the effectiveness of this method varies depending on the physical properties and the chemical composition of the spilled oil. The rate of evaporation and emulsification processes and the subsequent changes in the characteristics of oils have a major influence on the usefulness of in situ burning. [85] In addition, temperature, wind speed and the thickness of the oil layer restrict the use of this method. [86] This method is useful when the layer of oil is relatively thick, the oil is recently spilled and the oil is not too emulsified. [87] Furthermore, this method is not appropriate on water if the sea is rough. In Sweden, in situ burning is used restrictively and only in emergency situations. [88]

### 5.5.4 Absorbents

Absorbents are frequently used close to shores and ports dealing with small oil spills. After usage of the absorbents, manual or mechanical recovery processes is used to collect the polluted absorbent. Larger oil spills may result in a large quantity of polluted absorbents and the destruction of the absorbents could be expensive. Polluted absorbents are categorized as hazardous waste, which is much more complicated and expensive to manage than normal waste and the user is responsible for the disposal. Permission has to be granted from the authorities regarding the the transportation, storage and treatment of the waste. [89] [90] [91]

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82 Fejes, 1993
83 Appendix A, Terminology
84 Fejes, 1993
85 Appendix B, The behavior of oil in water
86 Nordvik, 2005
87 Appendix B, The behavior of oil in water
88 Fejes, 1993
89 Fejes & Lindblom, 2003
90 See chapter 4 for more information regarding absorbents
91 Fejes, 1993

# 6 Internal factors

*The internal analysis describes relevant internal strengths and weaknesses of the product made by Södra. Internal factors in this study include important product performance, internal strategic resources and capabilities, product profitability and the environmental effects of the product.*

## 6.1 Product performance

According to the interviewees, the most important performance dimensions are the absorptive capacity and manipulability which are described in this chapter.

The *absorptive capacity* depends upon the oil type and the effectiveness of the absorptive mechanisms. The product mainly uses the absorption and adhesion mechanisms. Absorption works best with lighter oil types such as gasoline and diesel since high viscosity oil types is too thick in order to be absorbed into the granule. Adhesion works better with thicker oil types such as medium crude oil and lube oil where the oil is added to the surface of the pellets. [92] The absorptive data for our pellets is 0,6 - 0,7 g oil / l absorbent for oil types with light and medium viscosity[93]. For heavy oil types, such as bunker fuel and asphalt oil, absorbents are not an appropriate sanitation method since the absorptive mechanisms decrease radically. [94]

Concerning the *manipulability*, which is an important product performance dimension, the fiber granules have some advantages compared to other absorbent products. According to Einar Böhmer, the inventor of the product, the particles are easier to gather after use since they are larger than most other absorbents. Another advantage is that when exposed to oil the fiber granules do not sink in water unlike many other absorbents. [95] [96]

[93] Fejes et al., 1999
[94] Løset, 1993
[95] Interview with Einar Böhmer, Inventor, 2008-02-24
[96] See chapter 7.2.3 for a full description regarding the dimensions of manipulability

## 6.2 Strategic resources and capabilities

Strategic resources and capabilities studies internal factors of Södras organization that is relevant in this thesis.

### 6.2.1 In house competence

Södra Cell is one of the world's leading producers of pulp. Most of the raw material for Södras pulp comes from forests owned by Södra´s members. Södra Cell has chosen to concentrate their operations and their expertise on pulp and do not work with the paper making process. In the production chain, from the raw material in the forest to finished paper products Södra has an important role in the value chain. Södra Cell possess a strong competence regarding cellulose fibers, the most important component in paper. [97]

Core competence is an ability that a firm do well, provides customer benefits, is not easy to imitate and can be leveraged into many products and markets. The real sources of advantage are to be found in management's ability to consolidate corporate-wide technologies and production skills into competencies that empower individual businesses to adapt quickly to changing opportunities. [98]

Even though the raw material of the absorbents is a business activity that relies on Södras core competence, absorbents could not be regarded as a product that relies on their firm-specific competences. Södra has a strong competence regarding the material and processes involving the production of absorbents. However, they lack knowledge of the absorbent market. It will probably be difficult to be updated of information regarding changes in the absorbent market. Södras could therefore have difficultiveness to focus on this activity and in adjusting to external market changes. It could be difficult to keep track of the competitors and customers.

### 6.2.2 Access to raw material

The product could be regarded as a completely new product to Södra but the company possesses control of the supply of raw material to the production of the product. Forward integration occurs when a firm moves downstream with respect to product flow, such as a manufacturer buying a retail chain. [99] The product from Södra could be considered to be a

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[97] www.sodra.com, 2008-04-16

[98] Tidd et al., 2005

[99] Aaker: Chapter 13, 2005

forward integration strategy since Södras controls the supply of the raw material. Vertical integration potentially provides access to supply and demand and entry into an attractive business area. The drawback is however the risks of managing a very different business and the reduction of strategic flexibility. [100] Specific benefits include no transport costs and no use of intermediaries such as wholesalers or retailers regarding the obtaining of the raw material. The control of the supply of raw material could pose as an entry barrier for competitors and a strategic advantage for Södra.

### 6.2.3 Access to combustion equipment

Södra has access to several industrial furnaces including recovery boilers, mesa- and bark furnaces. These industrial furnaces functions as thermal power stations that could be used to generate both heating energy and electricity. The pans are a component of the paper pulp making process and are often combined with a chimney gas purification process. [101] The access to combustion equipment could provide a strategic advantage for Södra regarding the destruction of absorbents.

Polluted absorbents are categorized as hazardous waste, which is much more complicated and expensive to manage than normal waste and the user is responsible for the disposal. Permission has to be granted from the authorities regarding the the transportation, storage and treatment of the waste. Some industrial pans could manage hazardous waste, including many of the pans in the paper pulp industry. However, it requires permission from the authorities. [102] SAKAB AB is a company that takes care of hazardous waste and has permission to incinerate polluted absorbents. SAKAB charge 2-5 SEK/kg for the incineration, which illustrates the costs for getting rid of the polluted absorbents. [103]

According to the customers, they expressed their opinion that the destruction of absorbents costs as much as their purchase. By formulating contracts with the customers, Södra could incinerate the absorbents. Contracts regarding the destruction could thus benefit the company with a competitive advantage.

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100 Aaker: Chapter 13, 2005

101 www.sodra.com, 2008-05-05

102 Fejes & Lindblom, 2003

103 Interview with Elisabeth Szep, SAKAB AB, 2008-05-19

### 6.2.4 Trademark

Since the absorbents are relatively homogeneous products the main asset that separates the products is trademarks, which inflict the perceived value and the confidence the trademark instill in customers. This value is reflected in the price premium that customers are willing to pay for the branded product over that for an unbranded or unknown brand. [104] Since Södra is not established in this industry they will probably need additional advertising and promotional costs in order to establish customer loyalty and awareness of their product. Södra has however, as an actor in the paper pulp industry, some recognition for their trademark.

## 6.3 Assessment of costs and profitability

In order to estimate which potential revenues this product may bring a calculation regarding the products costs has been conducted. More specifically, a contribution margin calculation was used to analyze the products profitability. The following contribution margin calculation serves as a proposal and guidance of the profitability since there is currently no production.

Table 4 shows the cost calculation for year three, which describes the calculation for a more established business. The first and second year would involve larger marketing costs and smaller turnover, thus achieving less revenue. [105] The costs in this scenario could reflect the typical costs for a company in the absorbent business.

[104] Grant: Chapter 5, 2005

[105] See Appendix E for a detailed description regarding the posts in the calculation and an overview of all the years

**Table 4 Contribution margin calculation for year three**

**Year 3**

| **Production cost calculation** | Amount (SEK) | Cost unit | Explanation |
|---|---|---|---|
| Revenue | | | |
| Turnover | 2 000 000 | Price x Volume | 2.5 SEK x 800 000 L |
| Variable costs | | Volume dependant costs | |
| Raw material | -200 160 | Material cost x Volume | 2780 SEK/ton |
| Packaging | -30 000 | Material cost x Volume | 1.5 SEK / 40l bag |
| **Contribution margin 1** | 1 769 840 | | |
| | | | |
| Fixed costs | | | |
| Depreciation packing machine | -50 000 | Yearly depreciation | 5 years depreciation |
| Depreciation pulp dryer | -15 000 | Yearly depreciation | 5 years depreciation |
| Salary (two persons) | -930 000 | Yearly salary including taxes | |
| Marketing costs | -100 000 | Yearly costs for marketing | Cost for commercials, sales etc |
| Adminstration costs | -50 000 | Yearly costs for the administration | Cost for office supplies, rent etc |
| **Contribution margin 2** | 624 840 | | |
| Alternative cost | -181 440 | Alternative cost for the pulp | Profit from paper pulp |
| **Net profit** | 443 400 | | |

With a price on 2,5 SEK/l the product could be considered to be in the middle price class of absorbents compared to the competitors. With 230 workdays each year (that is quite normal) and a production of 172 bags (40L) of absorbents each day the yearly volume becomes 800 000 liters. Our estimation of the volume is derived from the competitors' turnaround. 2 Mkr SEK/year is a reasonable turnaround compared to the competitors. The yearly turnaround would then be 2 million SEK/year with a revenue of more than 675 000 SEK/year. This turnover is reasonable when benchmarking the turnover to the competitors businesses. [106]

### *Critical volume*

The critical volume with a price on 2,5 SEK/l is 608 000 liters absorbent, which entails 66 bags/day with 230 working days. With this volume contribution margin 2 is zero which implicates that there is no profit but neither there is a loss. [107]

**Table 5 Overview of the linkage between sold quantity and profitability**

| | Price/L | Litres/year | Bags/day | Contribution margin 2 (SEK) |
|---|---|---|---|---|
| Year 3 | 2.5 | 800 000 | 172 | 625 000 |
| Critical volume | 2.5 | 608 000 | 66 | 0 |

[106] Chapter 7.3.2 contains information regarding the competitors turnover and price on their products

***Labour and capital costs***

In the calculation it is obvious that the salary is a critical cost. In the scenario there are two full time employees but it is difficult to say how many employees that are needed for the business activity. Since the labour cost is critical the numbers of employees have a very high impact on the profitability. By making the production more automatic it would be possible to minimize the labour costs. However, the technical equipment used in the scenario is relatively basic and inexpensive. With a more automatic production process the technical equipment has to be more sophisticated. The expenses for the technical equipment would then probably be larger even though this has not been studied in detail.

[107] Appendix E, Production cost calculation

## 6.4 Environmental effects

Considering the environmental effects of Södras product the thesis follows the framework in the theoretical chapter, which is a simplified model of a LCA analysis.[108] Table 6 represents the model which applies a score based on how environmental friendly the product is, the higher the score is the more environmental friendly the product is. [109]

**Table 6 Environmental chart of environmental effects**

| **Evaluation chart of environmental effects** | | | | | |
|---|---|---|---|---|---|
| Manufacturing | | | Yes | | No |
| Does the absorbent consist of carbon-neutral material? | | | 3 | | 0 |
| Does the absorbent consist of renewable material? | | | 3 | | 0 |
| Is the absorbent biodegradable? | | | 3 | | 0 |
| Is a detailed product sheet included? | | | 3 | | 0 |
| Absorption capacity [g oil/l absorbent] | >0.7 | 0.6-0.7 | 0.5-0.6 | 0.4-0.5 | <0.4 |
| How high is the absorptive capacity? | 5 | 4 | 3 | 2 | 0 |
| Usage | | | God | Average | Bad |
| How good is the absorbents capability of bearing? | | | 2 | 1 | 0 |
| How well is the resistance to crumbling? | | | 2 | 1 | 0 |
| How good is the absorbents saturation time? | | | 2 | 1 | 0 |
| How easy is to collect the absorbent after usage? | | | 2 | 1 | 0 |
| Destruction | | Yes | Yes | No | Yes |
| Is it possible to incinerate polluted absorbents? | | 7 | | 0 | |
| Are polluted absorbents deposited? | | | | 3 | 0 |
| Summation | | | | | **Σ x** |

### Manufacturing

Södras product consists of mechanical pulp, consisting of *carbon-neutral*[110] material, and has no addition of extra chemicals in the wood. This manufacturing method has several environmental advantages since the raw material is renewable. According to the framework the product gains twelve points (12/12). [111]

### Absorption Capacity

The products maximum absorptive capacity is 0,7 g oil / liter absorbent, which is quite good compared to the competitors products. The product thus gains four out of five points. [112]

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[108] See Appendix C for the modifications regarding the framework used for the environmental effects

[109] Fejes & Lindblom, 2003

[110] Appendix A, Terminology

[111] Soteland & Bohmer, 1993

**Usage**

The product has a low density and high hydrophobicity and will therefore be able to float on water for some hours, even without being exposed to oil. The bearing capability is therefore average since its better than bark products but worse than cork- and cotton products. Concerning the ability to maintain its solid state it is also considered to be average because it may crumble in rough weather conditions. The saturation time could also be considered to be average since it is nor better or worse than other organic products. The absorbents are relatively large and are thus easy to collect. The result on this dimension is five out of eight points. [113]

**Destruction**

Concerning the destruction it is possible to incinerate the fiber pellets since it consists of organic material. Since the product is not deposited it receives the maximum ten out of ten points.

**Result of the evaluation**

The product gets 31 points out of 35 points, which is relatively good compared to the competitors' products. Since the product consist of organic material without any additives it is possible to achieve low environmental impact. A comparison and an overview of the environmental effects of other absorbents are found in chapter 7.4.

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[112] Løset, 1993

[113] Løset, 1993

# 7 External factors

*The external analysis is divided into four chapters; market review, customer analysis, competitor analysis is and an analysis of the products environmental effects. The chapters are analyzed based on empirical data gathered from interviews and other sources of information.*

## 7.1 Market review

The market review includes identified potential segments of industries and authorities using absorbents. The delimitations are described and after that the selected segments and organizations are presented.

### 7.1.1 Overview of the potential market

The identification of potential customers includes industries that manage large amounts of oil, industries using a lot of machinery, the transport industry and relevant public organizations. Figure 14 is used as a guideline for an overview of the identified segments.

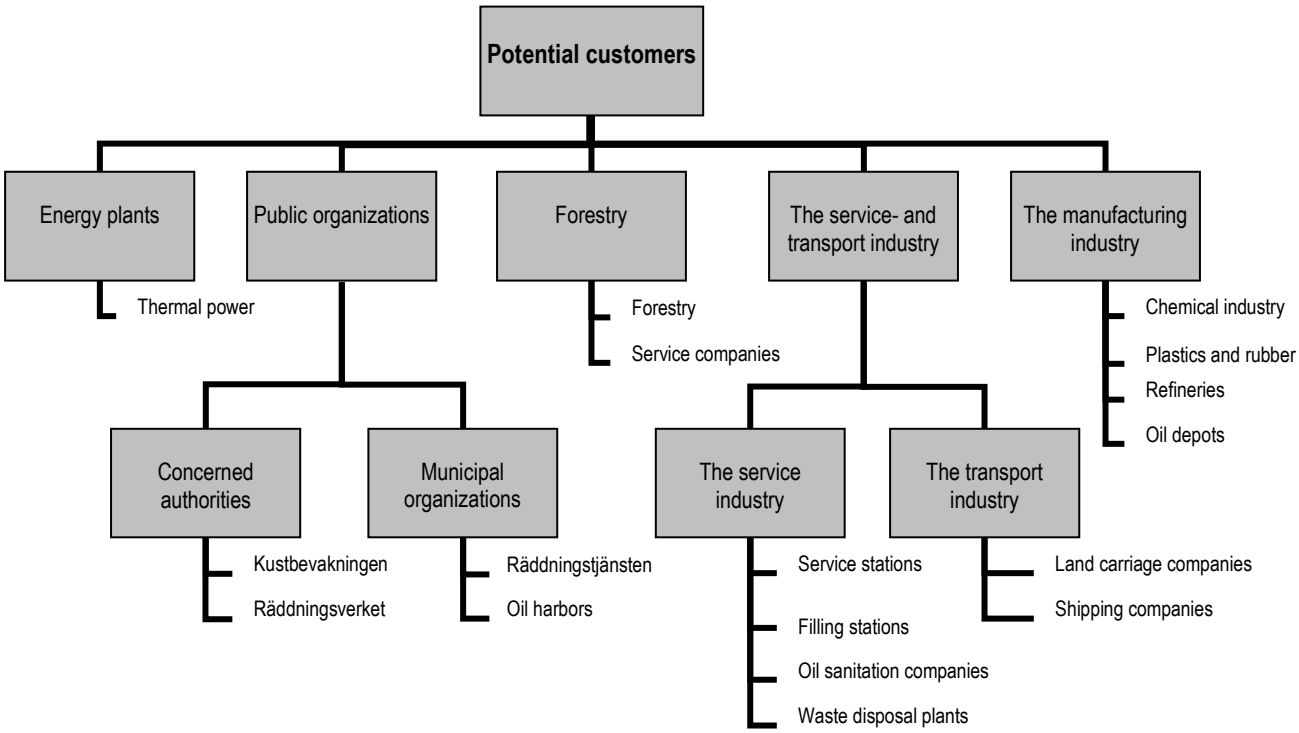


**Figure 14 Potential absorbent market**

The energy industri include thermal power plants that often are runned on oil, which implies that the plants could cause oil spills. Public organizations include concerned authorities, which have a part of the responsibility when oil spills occur. For example, Räddningsverket

owns five storage facilities for sanitation products that are used by the Kustbevakningen. Kustbevakningen are responsible for oil spills on sea and use their own equipment. The oil harbours are a part of the communes and manages loading/unloading of oil from ships. The forestry segment includes forestry and service related companies. These industries use a lot of heavy machinery that quite often cause leaks of hydraulic oil[114]. Potential segments in the service industry include private companies which manage oil or deal with oil spills. Identified segments include service stations, filling stations, oil sanitation companies and waste disposal plants. The transport industry includes transport on sea and land where the segments are land carriage companies such as trucks and railways and shipping companies. The manufacturing industry includes industries which use petroleum or petroleum products in their production such as the chemical, plastics and rubber industry. Table 7 includes a more detailed description of the size of the segments. [115]

[114] Interview with Eric Lundin, 2008-03-18

[115] www.spi.se, 2008-03-25

**Table 7 Potential absorbent market 116**

| Potential market | Relevant segments | No of organizations | Turnover (MSEK) | No of employees |
|---|---|---|---|---|
| Public authorities | | | | |
| | Concerned authorities | 2 | n.a | 1 600 |
| Municipal organizations | | | | |
| | Oil harbors | 64 | n.a | n.a |
| | Räddningstjänsten | 204 | n.a | 15 700 |
| The service industry | | | | |
| | Service stations | 11 207 | 34 000 | 19 300 |
| | Filling stations | 1 960 | 62 000 | 9 300 |
| | Oil sanitation companies | 91 | 12 000 | 4 502 |
| | Waste disposal plants | 332 | n.a | n.a |
| The transport industry | | | | |
| | Land carriage companies | 14 384 | 83 000 | 58 800 |
| | Shipping companies | 245 | 40 000 | 13 100 |
| The manufacturing industry | | | | |
| | Chemical industry | 952 | 148 000 | 34 800 |
| | Plastics and rubber industry | 1 636 | 40 000 | 21 100 |
| | Refineries and oil depots | 10 | n.a | n.a |
| Energy plants | | | | |
| | Thermal power stations | 210 | 29 000 | 4 900 |
| Forestry | | | | |
| | Forestry | 54 678 | 50 000 | 11 500 |
| | Related service companies | 594 | 5 000 | 1 800 |

### 7.1.2 Delimitations

Södras product is intended for use is on oil spills that occur in water, as described by the patent[117]. The delimitation thus focuses on organizations which are exposed to oil spills that may occur both in water and on land. Segments that could be exposed to oil spills on water include public authorities such as Räddningsverket and Kustbevakningen, municipal organizations that includes oil harbours and Räddningstjänsten near the coastline, oil sanitation companies, shipping companies, refineries and oil depots.

116 www.scb.se, 2008-03-04
www.avfallsverige.se, 2008-03-28
www.raddningsverket.se, 2008-03-17
www.kustbevakningen.se, 2008-03-28
www.sjofartsverket.se, 2008-03-28
www.eniro.se, 2008-04-01

117 Soteland & Bohmer, 1993

### 7.1.2 Selection of studied organizations

The selection of the studied organizations includes the segments described in Table 8.[118]

**Table 8 Studied segments [119]**

| Customer selection | Studied segment | Number of organizations | Studied organizations | Production capacity [million ton oil/year] | No of employees | Absorbent consumption [SEK/year] |
|---|---|---|---|---|---|---|
| Public authorities | Concerned authorities | 2 | 2 | n.a | 1 600 | 185 000 |
| Municipal organizations | Coastal Räddningstjänsten | 82 | 5 | n.a | n.a | 311 000 |
| | Oil harbors | 64 | 6 | 52.9 | n.a | 209 000 |
| The service industry | Oil sanitation companies | 91 | 6 | n.a | 4 500 | 238 000 |
| The transport industry | Oil shipping companies | 44 | 4 | n.a | n.a | 15 000 |
| The petroleum industry | Refineries | 3 | 3 | 24 | 1 300 | 25 000 |
| | Oil depots | 10 | 3 | n.a | n.a | 130 000 |

The thesis studies a small selection of these segments in order to study the customer's sanitation methods, the customer's usage of absorbents, how they use absorbents and what they value in absorbents. Differences in usage and values are described in the Customer analysis. The studied organizations are displayed in the table 9, which describes the organizations name, location and relative size.

118 See Appendix F for calculation regarding the approximate absorbent consumption

119 www.spi.se, 2008-03-28
Interview with Per Sjöberger, Svensk Redareförening, 2008-03-10
www.sjofartsverket.se, 2008-03-28
www.raddningsverket.se, 2008-03-20

**Table 9 Investigated organizations 120**

| Selected segment | Location | Production capacity | No of employees |
|---|---|---|---|
| Concerned authorities | | | |
| Kustbevakningen | Sweden | n.a | 700 |
| Räddningsverket | Sweden | n.a | 900 |
| Coastal Räddningstjänsten | | | |
| Göteborg | Gothenburg | n.a | 850 |
| Umeå-Robertsfors-Vindeln | Umeå | n.a | 170 |
| Östra Blekinge | Karlskrona | n.a | 210 |
| Södra Stockholm | Stockholm | n.a | 400 |
| Södra Skåne | Malmö | n.a | 530 |
| Oil harbours | | (million ton oil/year) | |
| Stockholms Hamn AB | Stockholm | 2 | 270 |
| Göteborgs Hamn AB | Gothenburg | 18 | 1 170 |
| Copenhagen-Malmö Port AB | Malmö, Copenhagen | 3 | 470 |
| Preem Petroleum AB, Brofjorden | Lysekil | 18 | 600 |
| Karlshamns Hamn AB | Karlshamn | 2 | 85 |
| Strömstads Hamn | Strömstad | 0.05 | n.a |
| Sanitation companies | | | |
| Stena Recycling AB | Göteborg | n.a | 636 |
| Entropi Sanerings AB | Sweden | n.a | 4 |
| Ragn-Sells AB | Sweden | n.a | 1 390 |
| Industrisanering i Södermanland AB | Eskilstuna | n.a | 20 |
| GR Sanering AB | Sweden | n.a | 131 |
| Industri och Skadesanering AB | Stockholm | n.a | 14 |
| Oil shipping companies | | (no of vessels) | |
| OljOla AB | Gothenburg | 1 oil vessel | 12 |
| BRP Transport AB | Gothenburg | 4 oil vessels | 12 |
| Tärntank Rederi AB | Gothenburg | 9 oil vessels | 170 |
| Broström Ship Management AB | Gothenburg | 15 oil vessels | 440 |
| Refinerys | | (million ton oil/year) | |
| Preem Petroleum AB | Gothenburg | 11 | 300 |
| | Lysekil | 5 | 600 |
| Shell Raffinaderi AB | Gothenburg | 5 | 150 |
| Nynäs Petroleum AB | Nynäshamn | 2 | 200 |
| | Gothenburg | 1 | 40 |
| Oil depots | | (million ton oil/year) | |
| Nordic Storage AB | Gothenburg | n.a | 13 |
| Norsk Hydro Olje AB | Stockholm | 0.15 | 2 |
| Svenska Shell AB | Jönköping | 0.2 | 4 |

120 www.affarsdata.se, 2008-03-26

## 7.2 Customer analysis

*The customer analysis describes the potential customers relative quantity of oil spills dealt with, their usage of absorbents, customer values and their unmet needs. This chapter studies the selected organizations from the market description.*

### 7.2.1 Managed oil spills

An indication of the use of absorbents could be the quantity of oil spills managed by each segment. The segments differ significantly regarding the oil types managed. Crude oil is often managed in oil depots, refineries and oil harbours. Diesel, fuel oil and lighter oil fractions are commonly managed in the segments which are related to accidents involving automotives and ships. These segments include public authorities, coastal Räddningstjänsten, sanitation companies and oil shipping companies. Accidents involving lube oil is associated to segments that use a lot of machinery. Figure 15 describes the relative amount of oil spill dealth with across the segments.

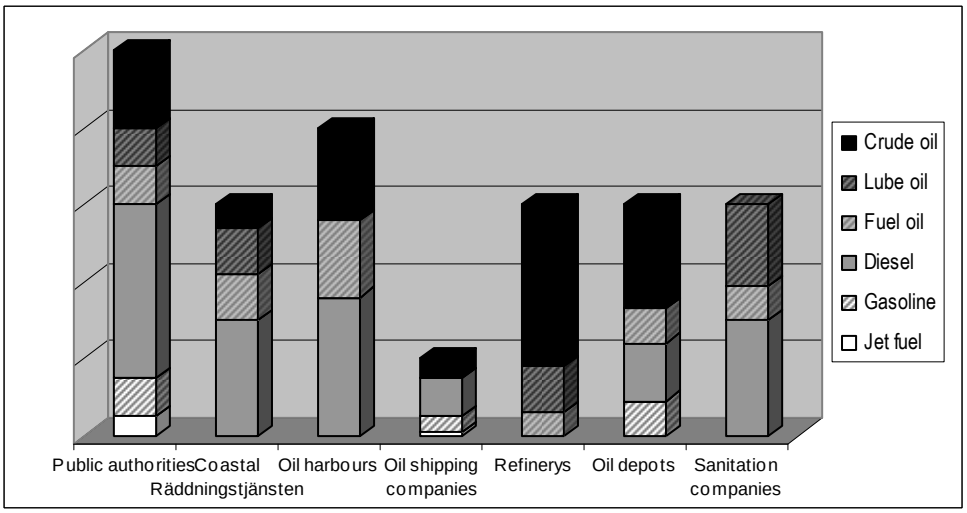


**Figure 15 Relative amount of oil spills dealt with**

### 7.2.2 Usage of absorbents and other sanitation methods

The sanitation methods vary between the organizations in the segments. Many different methods are used on water and on land. On water, the most common methods are the use of high-water booms (that is used to encircle the polluted area) and absorption booms. The absorption booms consist of absorbents packaged into a net in order to keep the absorbents from dispersion in the water. The booms are easier to collect than granules. Another method is

the use of mechanical methods, such as skimmers, which is more effective but more expensive. This method is often used by Kustbevakningen[121].

On land the most common methods is the use of organic and inorganic absorbents, which are shaped as granules. According to Krister Lindau from Räddningstjänsten absorbents are only used for small oil spills[122]. Inorganic absorbents, such as absol, are often used indoors and on roads where it is important with an absorbent with slip-reducing and chemical-absorbing properties. Organic absorbents often react with strong acids and are not suitable for chemicals[123]. These absorbents are often used outdoors, such as on shorelines, inland waters and in sensitive areas. Absorption booms are also used to some extent on land. Another method is the usage of sludge suction vehicles, which is very effective on large oil spills. This method is often used by sanitation companies. Table 10 is used as a brief description of the used sanitation methods in the studied segments.

**Table 10 Common sanitation methods**

| Segment | Common sanitation methods | Usage areas |
|---|---|---|
| Public authorities | Mechanical methods, Absorbents, Booms | Water, Outdoors |
| Coastal Räddningstjänsten | Inorganic absorbents, Absorption booms | Water, Roads |
| Oil harbours | Organic absorbents, Booms | Water, Outdoors |
| Oil shipping companies | Absorbents, Absorption booms | Water, on deck |
| Refinerys | Sludge suction vehicles, Organic absorbents, Booms | Water, Industrial area |
| Oil depots | Sludge suction vehicles, Absorbents | Industrial area, Filters |
| Sanitation companies | Sludge suction vehicles, Absorbents, Booms | Water, Outdoors/Indoors |

There are many potential customers for absorbents but the consumption is usually very small. The studied segments are very concerned about safety prevention, and thus especially regarding oil spills. For example, nowadays oil cargo ships often use double-hull and facilities are equipped with complex safety systems.[124] The use of effective safety prevention systems and the small size of the studied segments result in a low consumption of absorbents. Absorbents are often purchased to increase the preparedness for accidents involving oil spills, but they are not used very often since oil spills are not that common. The absorbents are often stored for several years without ever being used. The approximated absorbent consumption for each segment is shown in Figure 16.

121 Interview with Jan Fälteke, Kustbevakningen, 2008-02-19

122 Interview with Krister Lindau, Räddningstjänsten, 2008-03-15

123 Fjelldal, 1993

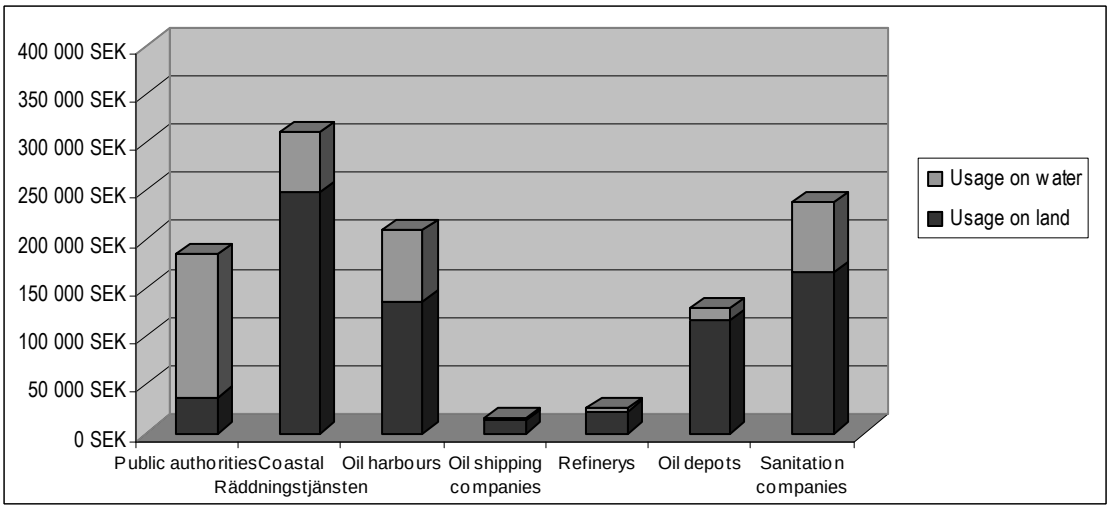


**Figure 16 Approximate usage of absorbents**

Figure 16 displays the absorbent consumption on land and on water. Absorption booms are often used in water and granules are often used on land. Absorption booms were also used to some extent in industrial facilities as a barrier around leaking machinery equipment. Figure 17 displays the usage of different types of absorbents. Synthetic absorbents were not used by the organizations in the studied segments. Inorganic absorbents are often used on land as granules. Organic absorbents were used both as granules and absorption booms.

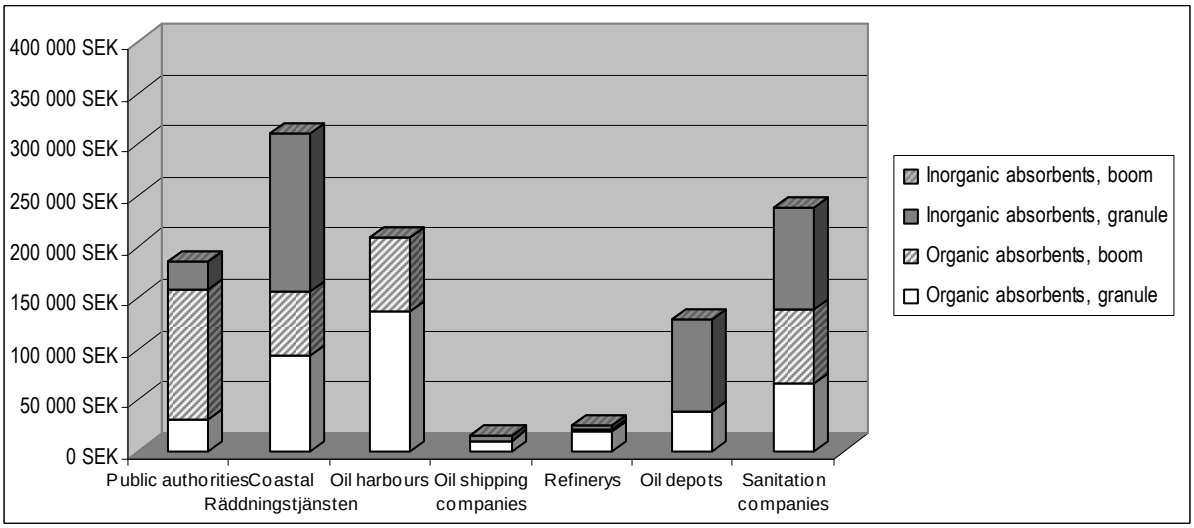


**Figure 17 Approximate use of absorbents**

124 www.europa.eu, 2008-05-06

### 7.2.3 Customer values

From the interviews it was possible to identify the most important customer values. The perceptions of the importance of the values are different in the segments but it is possible to see some similarities. The most frequently mentioned values in the interviews were price, trademark, absorptive capacity and manipulability.

The absorbents are low priced products, which are purchased in small quantities by many different organizations. The product could be characterized as a low-priced item which involves a low involvement purchasing process and the decision making process is minimal. In the interviews it was possible to see a pattern that the customers' decision making process is often founded on very vague incentives and imperfect knowledge of the products. [125] What the customer valued in an absorbent is different regarding if they were first-time buyers or returning customers. Price and trademark was perceived as more important values for the first-time buyer according to the interviewees.

The *price* of the absorbents was considered to be important according to the interviewees but since absorbents is a cheap product the customer did not thought the price was crucial regarding their purchase of absorbents. For first-time buyers price could be considered to be more important since these customers are not aware of other important performance dimensions regarding the manipulability and destruction. From the interviews it was possible to see a pattern that price was more important in public organizations and less important in private organizations.

The *trademark* is perceived as the confidence the brand inflicts in the customers and since absorbents is a relatively homogeneous product trademark is an important asset that separates the products from each other. This value is reflected in the price premium that customers are willing to pay for the branded product over that for an unbranded or unknown brand[126]. Established trademarks in the industry, such as Absol, are perceived by some customers to be reliable and often bought since the brand inflicts trust in the customers. By establishing a product as a major actor it may be easier to capture larger market shares since the customers usually buy what they perceive be well-known and used by other customers.

[125] Mullins et al: Chapter 5, 2005

Regarding the *absorptive capacity*, the small segment of oil shipping companies valued absorptive capacity to a large extent. The reason could be that the segment is not exposed to many oil spills and are consequently unaware of other important dimensions considering the usage and the destruction. Many high-usage customers had the opinion that absorbents did not differentiate particularly in absorptive capacity.

The *manipulability* was considered to be important by many segments. This dimension was regarded to be more important for high-usage customers. The customers' definition of manipulability was very different since the customers had different usage areas for the absorbents. For example, some customers used the absorbents on roads and other used them on shorelines. Table 11 displays explicitly valued dimensions of manipulability of the segments. According to the interviewees, the most important dimensions were "Not flying around" and "Easy to pick up".

**Table 11 Nine dimensions of manipulability**

| Nine dimensions of manipulability | Explicitly valued by the following segment(s) | Specific usage area |
|---|---|---|
| Small storage volume | Coastal Räddningstjänsten, Oil harbours | Fire-trucks, Stockpiling |
| Complete removal | Refineries | No specific |
| All round product | Sanitation companies, Coastal Räddningstjänsten | No specific |
| Water resistant | Oil depots, Coastal Räddningstjänsten, Sanitation companies | Outdoors |
| Capability of bearing | Sanitation companies, Coastal Räddningstjänsten | Outdoors |
| Low weight of the bags | Räddningstjänsten | No specific |
| Not flying around | Oil depots, Oil shipping companies, Coastal Räddningstjänsten, Oil harbours | Outdoors, Roads |
| Slip reducing | Sanitation companies, Coastal Räddningstjänsten | Roads |
| Easy to pick up | Coastal Räddningstjänsten, Oil shipping companies, Sanitation companies | No specific |

The *destruction* of the absorbents was considered to be important by most of the segments according to the interviewees. Some of the organizations thought that absorbents created too much waste that was expensive to get rid off and consequently they tried to minimize their use of absorbents. Other organizations enounced that it was equally expensive to take care of the waste produced by the absorbents as their purchase of absorbents. The oil shipping companies, which did not use absorbents to a great extent, did not think that the destruction was important since they hired sanitation companies to take care of their waste.

[126] Grant: Chapter 5, 2005

## 7.3 Competitor analysis

*The competitor analysis describes the entry barriers in the absorbent industry, identification and selection of competitors, business information and product performance of the selected competitors.*

### 7.3.1 Entry barriers in the absorbent industry

If an industry earns a return on capital in excess of its cost of capital, that industry acts as a magnet to firms outside the industry. The absence of entry or exit barriers will cause the rate of profit to fall towards its competitive level regardless of the number of firms within the industry. [127] The absorbent industry consists of homogeneous products and it is quite inexpensive to set up a business. There where 71 different manufacturers and distributors in Sweden according to market review from 1998[128]. The businesses of the absorbent manufacturers were often very small and the low entry barriers could serve as an explanation of the relatively large amount of small absorbent manufacturers in Sweden.

### 7.3.2 Selection of competitors

The selected competitors were to a large extent identified in the interviews with the potential customers. Some other competitors were also selected by the authors, mainly because of their similar products. Interviews with experts on absorbents have also been carried out in order to identify the largest close competitors[129]. The selected competitors are absorbents in the granular shape or in absorbents booms. There was also no evidence of the use of synthetic products by the selected customers. Table 12 displays the selected competitors and information regarding their size, turnover and availability.

[127] Grant: Chapter 3, 2005

[128] Fejes et al., 1999

[129] Interview with Jonas Fejes, IVL Institute, 2008-01-18

**Table 12 Selected competitors** [130]

| **Business information** | Manufacturer | Availability | Turnover | Employees |
|---|---|---|---|---|
| Organic absorbents | | | (MSEK/year) | |
| Zugol bark | Zugol AB | Sweden | 3.5 | 3 |
| Abtek/Reba bark | Abtek Tore Sundquist | Norway | n.a | 1 |
| Ecobark | Hoby Energi AB | Sweden | 2.7 | 2 |
| Aquabaz | Bazig APS | Denmark | n.a | 7 |
| Terrabaz (industri absorber) | Bazig APS | Denmark | n.a | 7 |
| Fleet Tec GP | Svenska Fleet Tec AB | Sweden | 2.9 | 2 |
| Fleet Tec W | Svenska Fleet Tec AB | Sweden | 2.9 | 2 |
| Float absorb | Geogen Produktion AB | Sweden | 2.3 | 2 |
| Organic absorbents in booms | | | | |
| Ecobark | Hoby Energi AB | Sweden | 2.7 | 2 |
| Aquabaz | Bazig APS | Denmark | n.a | 7 |
| Fleet Tec GP | Svenska Fleet Tec AB | Sweden | 2.9 | 2 |
| Fleet Tec W | Svenska Fleet Tec AB | Sweden | 2.9 | 2 |
| Sjuntorp Länsor | Bergaflex AB | Sweden | 11.5 | 6 |
| Inorganic absorbents | | | | |
| Absol | Svesten AB | Sweden | 9 | 7 |
| Absodan | BS Kemi AB | Sweden | 15 | 9 |
| Sanol | Sanol AB | Sweden | 0.5 | 1 |
| Inorganic absorbents in booms | | | | |
| Absol | Svesten AB | Sweden | 9 | 7 |
| Sanol | Sanol AB | Sweden | 0.5 | 1 |

### 7.3.3 Business strategies

From the competitor's business ideas and strategies it was evident that absorbents were not the only product or service they performed. Many of the competitors have other sanitation products, devices and services. It is consequently difficult to interprete the absorbents part in the turnover. The absorbents were however an important business area for the competitors since their operations usually has a focus on the sanitation market or the absorbent market.

Core competence is an ability that a firm do well, provides customer benefits, is not easy to imitate and can be leveraged into many products and markets[131]. The absorbent product is very simple and is easily imitated by other actors or new entrants. It is thus arguable whether the competitors business is based upon a core competence since the products are easy to imitate. They have, however, a good understanding on the market and easily adjust to market changes since the absorbents are a part of their core activity. The core competence in this market could be the competitors knowledge of the market and their insights in selling

130 www.affarsdata.se, 2008-03-26

131 Tidd et al., 2005

strategies. Apart from selling on their own, the competitiors also often use selling agents for their distribution and selling of their absorbents.

### 7.3.3 Product performance

Table 13 illustrates the selected competitors' product information. Some of the competitor's products had the shape of granules and other products were only used in absorption booms. There were also competitors which used granules in nets or coatings that had the function of absorption booms.

**Table 13 Product information regarding the competitors**

| Product information | Material | Land/water | Price | Shape | Environmental score |
|---|---|---|---|---|---|
| Organic absorbents | | (L/W) | (SEK/l) | | |
| **Södras product** | **Cellulose** | **L, W** | **n.a** | **Granular** | **31 / 35** |
| Zugol bark | Bark | L, W | 1.9-2.2* | Granular | 28 / 35 |
| Abtek/Reba bark | Fir Bark | L, W | 3.2-3.6* | Granular | 28 / 35 |
| Ecobark | Fir Bark | L, W | 2.5* | Granular | 28 / 35 |
| Aquabaz | Cellulose | W | 5.6 | Granular | 31 / 35 |
| Terrabaz (industri absorber) | Cellulose | L | 1.9 | Granular (small) | 29 / 35 |
| Fleet Tec GP | Cellulose | L | 4.6 | Granular (small) | 29 / 35 |
| Fleet Tec W | Cellulose | L, W | 6.2 | Granular | 31 / 35 |
| Float absorb | Peat | L, W | 5.5 | Granular | 24 / 35 |
| Organic absorbents in booms | | | | | |
| Ecobark | Fir Bark | W | 24* | Booms | 31 / 35 |
| Aquabaz | Cellulose | W | 7.9 | Booms | 31 / 35 |
| Fleet Tec GP | Cellulose | L | 3.2 | Booms | 31 / 35 |
| Fleet Tec W | Cellulose | W | 4.3 | Booms | 31 / 35 |
| Sjuntorp Länsor | Cotton | W | 3.3 | Booms | 31 / 35 |
| Inorganic absorbents | | | | | |
| Absol | Mixture of minerals | L | 2.4* | Granular | 22 / 35 |
| Absodan | Mixture of minerals | L | 2.1* | Granular | 21 / 35 |
| Sanol | Mixture of minerals | L | 1.4 | Granular | 27 / 35 |
| Inorganic absorbents in booms | | | | | |
| Absol | Mixture of minerals | L | 2.8 | Booms | 25 / 35 |
| Sanol | Mixture of minerals | W | 4.5 | Booms | 28 / 35 |

The asterix ('*') indicates that the price information was retrieved from a distributor, otherwise the information was retrieved from the manufacturer. The manufacturers could often sell absorbents directly to the customers, especially if they bought a large volume.

Table 14 illustrates the absorptive capacity in the competitors' products. The most influential factors on the absorptive capacity depends upon the temperature, viscosity, the type of oil, and if the oil is spilled on land or in water.

The result is derived from the ASTM F 726 – 81 test, which is a standardized test used for absorbents. The oil types used in the test was Shell Fuel oil No 1 and Lube oil, which is a mixture of Shell Rimula 10 and Shell Rimula 30. The fuel oil could be described as oil with a light viscosity and the lube oil could be described as oil with a medium viscosity.[132]

**Table 14 ASTM test conducted by IVL institute in cooperation with SP in Borås 133**

| Absorption capacity | Material | Density | Fuel oil 1 | Lube oil |
|---|---|---|---|---|
| Absorption capacity | | | g oil / mL sorbent | g oil / mL sorbent |
| Organic absorbents (granular) | | | | |
| Södras product | Cellulose | 0.1 | 0.7 | 0.6 |
| Zugol bark | Bark | 0.25 | 0.6 | 0.7 |
| Abtek/Reba bark | Bark | 0.25 | 0.6 | 0.7 |
| Ecobark | Bark | 0.25 | 0.6 | 0.7 |
| Aquabaz | Cellulose | 0.1 | 0.7 | 0.6 |
| Terrabaz (industri absorber) | Cellulose | 0.3 | 0.7 | 0.6 |
| Fleet Tec GP | Cellulose | 0.2 | 0.7 | 0.6 |
| Fleet Tec W | Cellulose | 0.1 | 0.7 | 0.6 |
| Float absorb | Peat | 0.3 | 0.4 | 0.5 |
| Inorganic absorbents (granular) | | | | |
| Absol | Mixture of minerals | 0.5 | 0.6 | 0.6 |
| Absodan | Mixture of minerals | 0.5 | 0.6 | 0.6 |
| Sanol | Mixture of minerals | 0.1 | 0.6 | 0.6 |

The result from the experiment displayed that the absorption capacity did not vary notably between the materials of the absorbents. Furthermore, the absorbents used in the experiment had similar absorptive capacity.

132 See Appendix G for an overview of the experimental procedure of the ASTM test

133 Fejes et al, 1999

## 7.4 Environmental effects

*A comparison between our product and the competitors regarding the environmental effects is conducted in this chapter.*

Figure 18 and 19 comprise the result from the modified version of the simplified LCA framework[134]. A high score represents a product that is environmental friendly.

The first picture represents the score from the organic and inorganic absorbents in the granular form. The second picture is the result from the organic and inorganic absorbents in booms. A major difference is that the granular form usually has a better score regarding the manufacturing since the booms consists of extra material in the concealing. According to the interviewees, the booms are easier to use and especially easier to collect after use.

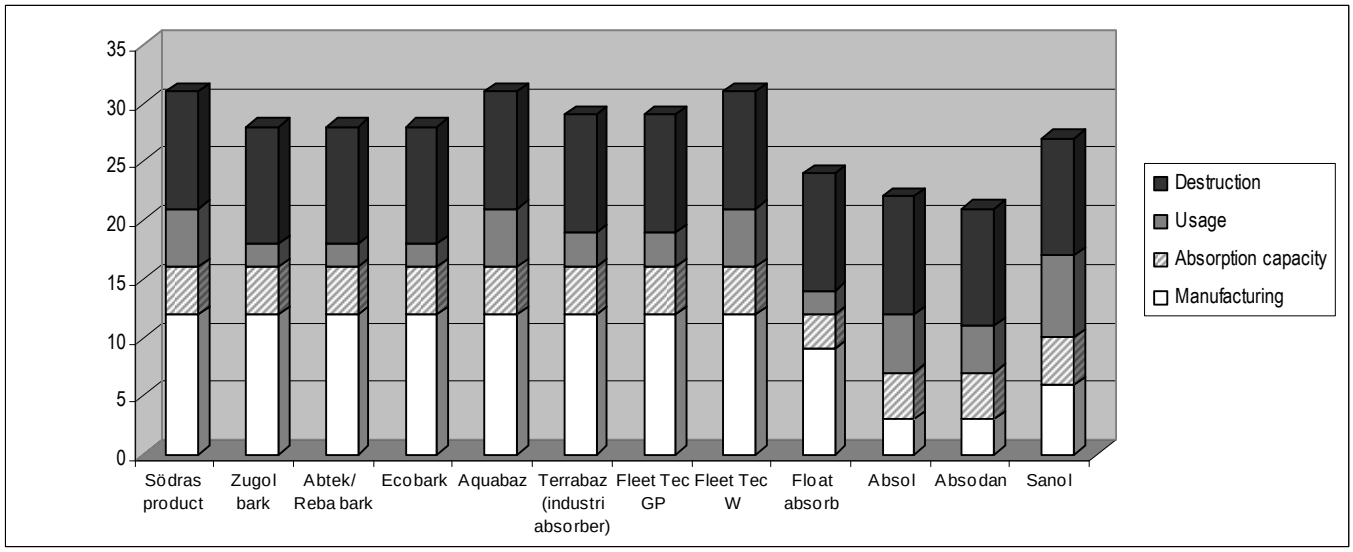


**Figure 18 Environmental score absorbents in the granular form**

134 Fejes & Lindblom, 2003

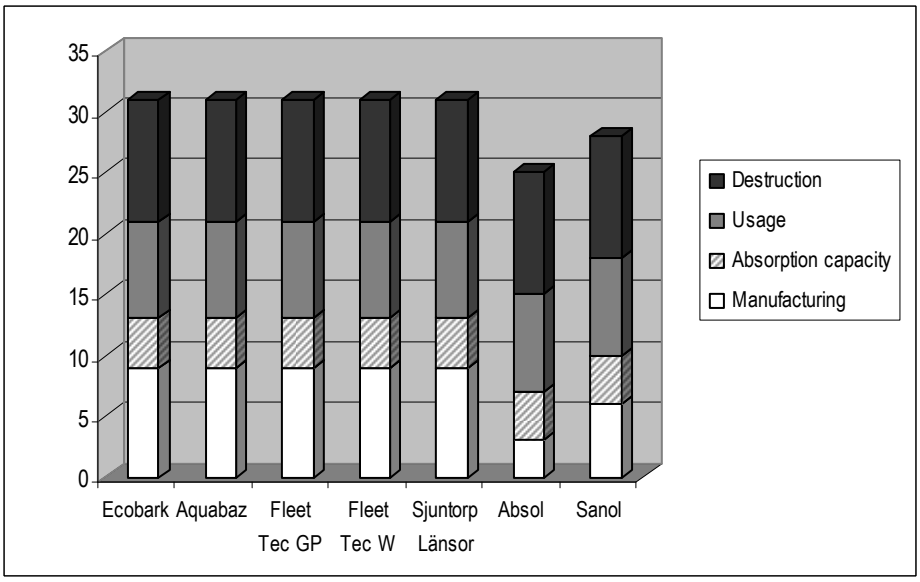


**Figure 19 Environmental score of absorbents in booms**

The environmental effects considering the *manufacturing* are different from the organic and inorganic absorbents. Organic absorbents are superior in this perspective since most of them are carbon-neutral, biodegradable and consists of renewable raw material. The inorganic absorbents has however a poor performance regarding this perspective.

Considering the *absorption capacity* it varied between the materials in the products. For example, most bark products had about the same absorptive capacity. Some of the inorganic absorbents had a relatively low absorptive capacity compared to the other products, which explains their low score.

The *usage* was very different from the products. Different shapes, materials, density are the reason for the wide-ranging score. Bark products, had an appearance similar to sawdust, which had a negative impact on dimensions considering the manipulability.

The score on the *destruction* dimension was the same for all absorbents since all of them could be incinerated. Therefore none of the absorbents had to be deposited.

## 7.5 Differences between Sweden and Norway

*Since Södra is operational in both Sweden and Norway it is relevant to analyze differences and similarities between the two countries regarding the absorbent market. The petroleum usages and the responsibility conditions can serve as a guidance for the the need for sanitation products in Norway.* [135]

### 7.5.1 The petroleum market

From figure 20 it is possible to see the difference between the import and export balance of petroleum and petroleum products between the two countries. The main difference lies in the production and export of crude oil. In Norway the production of crude oil is large and many domestic organizations depend upon the Norwegian oil production.

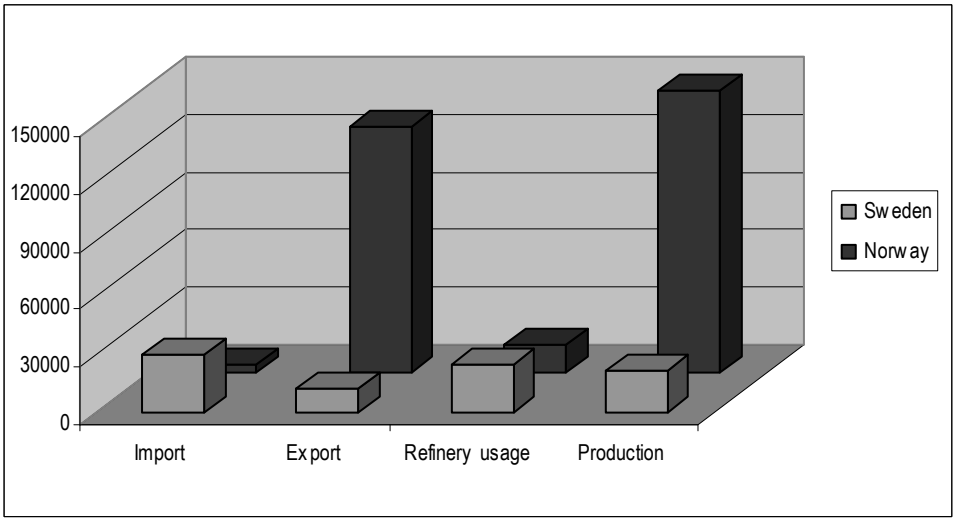


**Figure 20 Difference in the balance of petroleum resources for Norway and Sweden (000' $m^3$)** [136]

Organizations which depend upon the crude oil production in Norway includes drilling companies and related service companies, oil platforms and depots and specialized transportation companies. [137]

### 7.5.2 Responsibility conditions

The responsibility conditions are quite different on Norway than in Sweden. In Norway, the companies have a larger obligation to assist in the clean up process compared to Sweden. The larger oil companies that are active in the offshore industry are responsible to contribute in the

135 www.sodra.com, 2008-04-16

136 www.iea.org, 2008-04-15

sanitation work. However, when oil spills occur near the coastline the communes are obliged to assist in the cleanup. Since 2003, the public authority Ministry of Fisheries and Kystverket has the main responsibility for the prevention and sanitation against accidents involving large oil spills from vessels. The communes are responsible for the sanitation work for smaller oil spills on land and in harbors. The communes are also obliged to contribute with resources for oil spill sanitation when the actors involved in the oil spill do not have the adequate resources for the cleanup. [138]

**Table 15 Crude sketch of the responsibility conditions in Norway**

| Accident type | Obligations | Delimitation |
|---|---|---|
| Larger oil spill from offshore activity (oil rigs etc) | The oil company take operational contributions | None |
| Larger oil spill from oil vessels | Ministry of fisheries and Kystverket have operational responsibility | None |
| Smaller oil spills on land and in harbours | Communes have operational responsibility | Up to four nautic miles from the coastline |

### 7.5.3 Implications of the usage of absorbent products

The Norwegian market for oil production is different from Sweden since it exist more organization performing offshore activities regarding petroleum and petroleum products. Concerning the responsibility conditions, the Norwegian companies are obligied to take more responsibility for oil spills due to offshore activities.

These organizations have a strong incentive to prepare themselves against the risks of oil spills and it is likely that they are large consumers of oil sanitation products. Regarding the harbours in Norway they are likely to be exposed to more petroleum related activities than in Sweden. There is thus reason to believe that the absorbent market in Norway is larger on maritime waters and in the harbours.

137 www.marinenorway.com, 2008-04-16

138 Forsman, 2006

# 8 Results from the SWOT

*This section lists the most relevant and important factors regarding the SWOTs in the internal and external analysis. Furthermore, it explains the factors after the matrix.*

| | | |
|---|---|---|
| **INTERNAL** | • Access to raw material<br>• Easy to handle<br>• Environmental friendly<br>• Strong competence | • Product is not distinctive<br>• Limited application area<br>• Not good in windy conditions<br>• No slip reducing properties |
| **EXTERNAL** | • Marketing opportunity<br>• Occasional campaigns<br>• Collaboration with other actors<br>• Contracts regarding the destruction | • Not core activity<br>• Increased prevention for oil spills<br>• Market overcrowding<br>• Changing sanitation trends<br>• Oil is depleted as a natural resource |

The *strengths* explain the positive characteristics regarding the internal considerations. The strengths are what make the product competitive in the market.

- Södra has a unique access to their raw material since the company possess control of the supply of raw material to the production of the product. The manufacturing of absorbents could be considered to be a forward integration strategy[139]. Compared to its competitors, Södra have a possibility to reduce their transportation costs of the raw material. They also do not need to buy their raw material from a middleman. The control of the supply of raw material could pose as an entry barrier for competitors and an advantage for Södra.
- Another advantage is that the product is relatively easy to handle. With a relatively large particle size compared to its competitors it is easier to clean up the fiber granules and the bags are easy to carry because of the particles low density. The particles are also able to float because of its hydrophobicity and low density.
- Since the particles are made of organic raw material they also have a smaller impact on the environment compared to inorganic absorbents. The raw material is renewable and biodegradable, which makes the absorbent environmental friendly regarding the manufacturing process. Concerning the destruction it is also possible to destruct the product through incineration, which is an environmental friendly destruction method. According to the interviewees, many of the customers valued environmental friendly absorbents.
- Södra has chosen to concentrate their operations and their expertise on pulp and the pulp making process. Since the raw material consist of pulp it may be possible to use Södras strong competence as an advantage in the production, research and development of absorbents.

The *weaknesses* consist of negative characteristics regarding the internal considerations. It is important to identify internal flaws in order to launch a successful business strategy.

- The product from Södra is not unique compared to other absorbents in the granular shape on the market. There are already other granular absorbents made of cellulose that are very similar. The only notably difference is that these absorbents are usually made of recycled fibers. The authors of the thesis are unaware if the difference of the absorptive capacity differs significantly between recycled and new fibers. It should

139 Aaker: Chapter 13, 2005

however be noted that the absorbents on the market does not differentiate much in the absorptive capacity regarding the ASTM test carried out by IVL institute. [140]

- The product has a limited application area since different sanitation methods are used to target different sanitation problems. The competitors usually have a whole range of organic, inorganic and synthetic products in the diverse shapes such as the granular shape, carpets, pads and booms. Their comprehensive product range is used to completely cover the customer's needs and wants. If Södra only use one granular product they will limit themselves to a very narrow customer segment and since most of the interviewed customers purchase many different types of absorbent products this could be a considerable weakness. By expanding Södras product range using both booms and granules this problem could be countered to some extent. Another problem concerning the application area is that organic absorbents often react with chemicals and thus especially strong acids[141]. The application area is therefore limited to petroleum and petroleum products.
- Furthermore, the granules with their low density are not good in windy conditions. The granules will have difficultiveness to remain on the intended spot when the weather conditions are windy, especially if the surface is flat. According to interviewees many of the customers had the opinion that the absorbent preferably should stay on the surface. This dimension of manipulability was perceived to be more important for customers who used absorbents on roads.
- The fiber granule does not have any slip reducing properties, which will make it difficult to apply on roads and other surfaces where transportation occurs. Some inorganic absorbents are often used and marketed as slip reducing in order to profile themselves to customers who use absorbents on roads or indoors in facilities. Interviewees that valued this property included customers who used absorbents on roads or in industrial facilities.

The *opportunities* consist of positive characteristics regarding the external conditions. The opportunity involves identified factors that could be exploited.

- Södra could use the absorbents as a marketing opportunity. Since absorbents are a low-priced item that are purchased in small quantities by many different organizations,

[140] See Appendix G for a description of the experimental procedure of the ASTM test

[141] Fjelldal, 1993

Södra could increase their recognition by labeling their bag with their logotype. According to the market review, many different customer segments use absorbents in small volumes. Since the absorbent is organic and is used to sanitate oil spill the product could function as a strategy in order to create a better reputation of their trademark. The environmental friendly properties of the product also give Södra a good image to the general public, its customers and its suppliers. This could create better awareness regarding the organization and the absorbent thus function as inexpensive advertisement. A strong brand instills confidence in customers and functions as a reputational asset[142].

- It could be possible to launch the absorbents as a campaign by producing a large quantity of bags occasionally. By being able to produce a large quanitity of absorbents it could be possible to serve the markets needs in case of an extraordinary situation such as an accident involving a large oil pollution. The advantages of a campaign are to reduce the labour costs. The employees could for example work in their primary department and switch over to the absorbent production when needed.
- By collaborating with selling agents and/or competitors it could be possible to easier gain access to means for distribution. Many selling agents use online purchasing that could be an important distribution channel and marketing medium. Absorbents are purchased in small quantities by many different organizations, the market is very broad and the customers' involvement is low. Web-based purchase could therefore be an important distributive channel since it is possible to retrieve basic information of the product through websites. This statement has been supported by opinion of Mullins et al (2005) in the purchase of goods with low involvement purchase decisions[143]. It could also be beneficial to collaborate with the competitors in order to easier sell their products. By collaborating with an established competitor with a reputable trademark, such as Absol, it could be possible to gain access to channels of distribution. A reputable trademark could be a strong asset in the absorbent market since the customers usually pay a lot of attention to the trademark when they buy absorbents. It may consequently be easier to capture market share by collaborating with an existing competitor. This collaboration could be possible if the competitor's products are not in direct competition with Södras absorbent. Södras product could

142 Grant: Chapter 5, 2005

143 Mullins et al., Chapter 6: 2005

therefore serve as a complement to their product range. Södras could also offer the competitor access to incineration of absorbents. By following this opportunity Södra could counter their weakness regarding their limited application area.

- According to the interviewees, many of the users of absorbents expressed their opinion that the destruction of absorbents costs as much as their purchase. Polluted absorbents are categorized as hazardous waste, which is much more complicated and expensive to manage than normal waste and the user is responsible for the disposal. Some industrial pans could manage hazardous waste, including many pans in the paper pulp industry. However, it requires permission from the authorities. [144] SAKAB AB, which is an organization specialised in taking care of hazardous waste, have permission to incinerate polluted absorbents. They charge 2-5 SEK/kg for the incineration. [145] By formulating contracts with the customers, Södra could incinerate the absorbents in their industrial pans under the presumption that the customers are responsible for the transportation to the incineration plant. The customers then are benefought with decreased expenses and Södra has easier to capture larger market share and also gets energy from the incineration.

The *threats* list the external threats the business has to be aware of.

- Regarding Södras potential competitors, the absorbents were an important business area since their operations usually have a focus on the sanitation market or the absorbent market. The competitors have a good understanding of the market and can therefore easily adjust to market changes since the absorbents are a part of their core activity. Södra is a large producer of pulp and most of the raw material for Södras pulp comes from forests owned by Södra´s members[146]. Even though the raw material of the absorbents is a business activity that relies on Södras core competence, absorbents could not be regarded as a product that relies on their firm-specific competences. Södra lack knowledge and focus of the absorbent market and it will probably be difficult to be updated of information regarding changes in the absorbent market. It could therefore difficult to keep track of the competitors and customers since the absorbents are not Södras core activity.

144 Fejes & Lindblom, 2003

145 Interview with Elisabeth Szep, SAKAB AB, 2008-05-19

146 www.sodra.com, 2008-04-16

- Increased prevention of oil spills is a threat that is very realistic since oil-intense segments are very concerned about safety prevention, and thus especially regarding oil spills. According to interviewees, many customers of absorbents had the opinion that small oil spills have decreased significantly the last decade caused by an increased consciousness of prevention methods. For example, nowadays oil ships often use double-hull and facilities are equipped with complex safety systems.[147] Since absorbents are a technique that is used after the oil pollution the usage of absorbents could consequently be limited in the future.
- Market overcrowding is the threat that is faced when there are too many actors in the absorbent market. The absorbent industry consists of homogeneous products and it is quite inexpensive to set up a business. The entry barriers are thus quite low. There where 71 different manufacturers and distributors in Sweden according to market review from 1998[148]. The low entry barriers could serve as an explanation of the relatively large amount of absorbent manufacturers in Sweden and too many actors could lead to heavy competition and diminishing margins for the existing actors on the market.
- Another threat is the trends of the methods used in the sanitation work. For example, Räddningstjänsten mentioned that their has been an increased tendency to allow the oil to remain on the polluted area and let the nature take care of the breakdown process. In the past it was common to clean up the area completely, which implies removal of contaminated dirt and brushing polluted stones. [149] Alternative methods or a decreased use of sanitation products and methods could result in a lower usage of absorbents. For example, in an interview it was mentioned that an upcoming boom with new properties where tested in a laboratory that could increase the booms effectiveness[150]. Alternative methods could function as a better substitute for absorbents.
- Another distant threat is the depletion of oil as a natural resource. Since the consumption of oil is very large and it is continuing to increase the oil resources will

147 www.europa.eu, 2008-05-06

148 Fejes et al., 1999

149 Interview with Krister Lindau, Räddningstjänsten, 2008-03-15

150 Interview with Helena Winberg, Svenska Statoil AB, 2008-02-29

probably sooner or later be depleted[151]. Therefore the oil consumption needs to be replaced by alternative fuel. If the oil is depleted and alternative resources are used instead, the absorbent market will probably drastically decrease since the absorbent market has a large dependency of the oil market.

151 www.spi.se, 2008-05-06

# 9 Discussion

*The discussion is divided into four chapters; recommendations regarding marketing strategies, differences and similarities across different segments, a study of the differences and similarities between Sweden and Norway and a critical review of the framework.*

## 9.1 Recommendations

Södras potential product could probably never be a large business area for Södra since the market is crowded with competitors with similar products. Furthermore, absorbents are a low-priced item that are purchased in small quantities by many different organizations which makes it difficult to start up a large scale production and rely on a few large customers. The competitors usually have a turnover ranging from 1-3 MSEK/year, 1-3 employees and they usually have other business activities in the sanitation industry apart from the absorbent business. Based upon these circumstances, the authors of the thesis can not recommend Södra to start up a regular business in the absorbent industry. It could, however be possible to use the absorbents in a campaign by producing a certain quantity of bags and then store them. It would then be possible to reduce the labour costs since the employees could work in their primary department and switch over to the absorbent production when needed.

Oil spills are often characterized as small spills and may occur in many segments since oil is used in a wide range of industries. Absorbents are a cheap product with a low usage in many organizations. It is thus important to identify and try to market the product towards many different customer segments. The absorbent market has selling agents that are specialized in the selling of absorbent products to small customers. These agents could be contacted if the product is to be commercialized. It could also be advantageous to collaborate with competitors in order to sell the product.

Furthermore, it could be advantageous to profile the product as an absorbent that could be used in other application areas. For example, the absorbent could be used in filters and wells according to an interviewee[152]. It could also be possible to expand the product range by using the granules as a filling material in booms. These booms are often used on water since they are easier to handle than granular products and it would probably be quite easy and inexpensive to encyst the granules in a net and sell them as absorbent booms.

## 9.2 Critical review of the methodology

The thesis uses a qualitative investigation method for the research based upon semi-structured interviews. This methodology was considered since the authors were interested into understanding the customer's needs and values, usages and opinions of sanitation methods. Since our study has been of an exploring nature and we did not know the features of the market in advance the authors of the thesis thought that this method was appropirate for the thesis. A weakness with our methodology is that the result gathered from the interviews are somewhat biased since many of the interviewees had little knowledge of sanitation methods and thus especially absorbents.

Since many segments have not been studied, it is possible that there are other customer values that are not included in the thesis. It is also reasonable to believe that some of the other segments have a larger consumption of absorbents than the ones studied. Large segments such as service- and filling stations, the forestry industry, and land carriage companies could for example have a higher absorbent consumption and other customer values than the studied segments. But since these segments consist of many small organizations they are very difficult to study by using a qualitative research methodology.

The quantitative method could be suitable as a complement to our study. This method could have been suitable to verify large segments opinions about the relative importance of customer values in absorbents and their usages. It could thus be possible to conduct a more statistically reliable result from the customer's usages and values. The use of a quantitative methodology as a complement could increase the trustworthiness of the thesis but time constraints made it impossible to conduct. Regarding the production cost calculation, it only serves as a guidance of the potential costs and revenues of the product. The assumptions used to estimate the costs and revenues are found in Appendix E.

## 9.3 Critical review of the framework

The conducted SWOT analysis served as a useful tool given the purpose of the thesis even though the SWOT is constructed as a tool used to study organizations or strategic business units. In the thesis, SWOT was used as a framework since it shows a comprehensive overview of relevant internal and external factors. Another common model is the Porter Five Forces

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[152] Interview with Reiner Korkiamäki, Norsk Hydro Olje AB, 2008-03-12

model, which elaborates on the threat dimension in the SWOT but does not include the internal perspective. Since the authors of the thesis thought that the internal perspective was important to analyse the SWOT was convenient to use.

Critics against the use of SWOT view it as a generator of long lists of factors and general and often meaningless descriptions[153]. There was therefore a need to describe the factors in more detail. A problem concerning the result is that it was impossible to allocate the relative importance of the studied factors in the SWOT since an evaluation of the relative importance would be subjective and based on the authors personal opinions.

In the thesis, a simplified model of LCA has been conducted regarding Södras and its competitor's products. The simplified LCA is a modified version of Fejes & Lindbloms tool, which is used to analyze the environmental impact of absorbents[154]. The result from the analysis of the products could vary significantly from a complete LCA analysis since the simplified method gives a very approximate overview of the products environmental effects. An important issue, such as the energy consumption throughout the products life cycle is not studied in the simplified tool used in the thesis. Regarding the relative importance of the factors, the framework used in the thesis follows the the study of Fejes & Lindblom. [155] The absorption capacity of the products is included in the thesis since the absorption capacity has an effect on how much absorbents are needed to sanitate oil spills, which has an impact on the environment. The reliability of the method could therefore be questioned. As a result the study of the environmental effects in our study only serves as an indicator of the products influence on the environment and should not be confused with a LCA analysis.

153 Hill & Westbrook, 1997

154 Fejes & Lindblom, 2003

155 See Appendix C for more information regarding the modification of Fejes & Lindbloms' framework

# 10 Conclusion

*In the conclusion the research questions are answered by summarizing the most important findings from the SWOT analysis. This follows by suggestions for further research.*

The purpose of this thesis is to investigate the absorbent market and analyze how competitive Södras product is compared to similar products. For this purpose, three research questions were formulated:

- What does the absorbent market look like today regarding its competitors and customers?
- How competitive is Södras product regarding its performance and environmental effects?
- What could cost and eventual profitability be estimated to be?

Concerning the *first* question the absorbent market consists of many different market segments. These segments are relatively large and situated all around Sweden but the customers in the segments do not purchase large volumes of absorbents. Concerning the customers, absorbents are bought and used as preparedness for oil sanitation, which means that the product often is stored for several years without hardly being used. The competitors of absorbent products consist of many small companies with very similar products. The entry barriers in the market are very low and companies are constantly emerging and disappearing from the market because of the small margins. The competitors usually have other business areas in the sanitation business as well and the authors of the thesis do not regard the absorbent business as very lucrative.

Concerning the *second* question the competitiveness of Södras product could be analyzed by comparing the product against competitors and analyzing factors which determine Södras products internal performance. The product is quite similar to the competitor's products and it could not be considered to be a product with unique properties. The performance of Södras product is quite similar to the competitor's products regarding important dimensions such as absorptive capacity and manipulability. Concerning the environmental effects the products on the market are quite similar even though it is possible to conclude that Södras and other

organic products are better in this perspective since these products are more environmental friendly regarding the manufacturing process. A disadvantage of Södras absorbent is its limited application area since different methods are used for target different sanitation problems. The competitors usually have a large sortiment consisting of a whole range of organic, inorganic and synthetic absorbent products in the granular form, carpets, pads and booms to cover the customer's needs.

Concerning the *third* question absorbents are a cheap product and the market consists of many small buyers. Therefore it is important to sell a large quantity of absorbents to many different customer segments in order to achieve a moderate turnover. Regarding the production costs the labour costs is critical since it is high compared to other costs depending on the number of employees. It is however difficult to estimate how many employees that are needed for the business activity. By making the production more automatic it would be possible to decrease the labour costs. With a more automatic production process the technical equipment has to be more sophisticated. The expenses for the technical equipment would then probably be larger than the costs in the production cost calculation even though this has not been studied in detail. Regarding other important costs the operating expenditures for marketing and selling could be quite large since it is crucial to sell the product to many organizations. By collaborating with other actors in the industry it could be possible to avoid decrease the costs for selling and marketing.

Conclusively, the authors of the thesis do not think the business activity will be very lucrative based upon the maturity of the market, the low entry barriers, the competitor's size and turnover and the existence of similar products.

## 10.1 Suggestions for further research

The SWOT is criticized to provide a shallow foundation for analysis. Since the aim for the thesis was to provide an overview of the absorbent market and not to study one area in detail, the SWOT served a satisfactory tool for the market analysis. For further studies it would be interesting to use the result from the SWOT analysis and study possible business strategies. Areas that could be interesting for further studies include different application areas for the product (for example booms) and its implications on profitability. It could also be interesting to study one large customer segment in detail such as the manufacturing industry.

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# Appendix

*The following chapters are included in Appendix; Terminology, the behaviour of oil in water , environmental effects, production cost calculation, approximate absorbent consumption and a chapter including the experimental procedure of ASTM F 726 – 81.*

## Appendix A – Terminology

*Biological treatment agents:*

Biological treatment agents could include enzymes or micro organisms that catalyze the oxidation process of oil fractions into restproducts, carbon dioxide and water.

*carbon-neutral:*

The term carbon neutral can be used to describe energy that does not cause the release of any $CO_2$ at all.

*Discharge*:

Discharge is refered to oil spills which is conscious such as the cleansing of machines and tanks. Illegal discharges often occur in the Baltic Sea when oil tankers clean their tanks.

*Disposal*:

The transference of unwanted material, such as waste, to a new entity, a new place, or a new form.

*hydrophobic*:

A hydrophobic molecule is repelled by water. Literally hydrophobic means something that dislike water.

*in situ burning:*

In situ burning is the process of controlled burning of oil that is used to remove the oil from the surface of the water.

*LCA*:

Life Cycle Assessment is a technique to assess the environmental aspects and potential impacts associated with a product, process or service.

*Offshore*:

*Offshore* refers to waters situated off the shoreline but within waters under a country's control.

*Operational spill*:

Operational spills is refered to oil spills that occur under operational activities such as the leakages in hydraulic machinery.

*perlite*:

Perlite is an amorphous volcanic glass that has a relatively high water content.

*polypropylene*:

Polypropylene is a thermoplastic. It is a linear structure based on the monomer $C_nH_{2n}$. It is manufactured from propylene gas in presence of a catalyst such as titanium chloride.

*Polyurethane*:

Polyurethane is unique material that offers elasticity of rubber combined with the toughness and durability of metal. Polyurethane is manufactured by combining a diisocyanate and a diol through a chemical reaction.

*pumice*:

Pumice is a term for a volcanic rock that consists of solidified.

*Semi-structured interviews*:

The semi-structured interview use a series of general questions and takes the form as an interview guide but the sequence of questions can be varied and the interviewee has more flexibility concerning how to reply compared to the structured interview.

*surfactant*:

Surfactants are molecules consisting of a polar head and a nonpolar tail. They reduce surface tension and help formation of emulsions between different types of liquids.

*Value chain:*

Value chain refers to the chain of activities in an organization. Products pass through all activities of the value chain in order and at each activity the product gains some value.

## Appendix B – The behavior of oil in water

When oil is spilled into the marine environment a number of transformation processes occur that are referred to as the behavior of oil in water. This process depends very much of the oil type spilled and the weather conditions during and after the spill. [156]

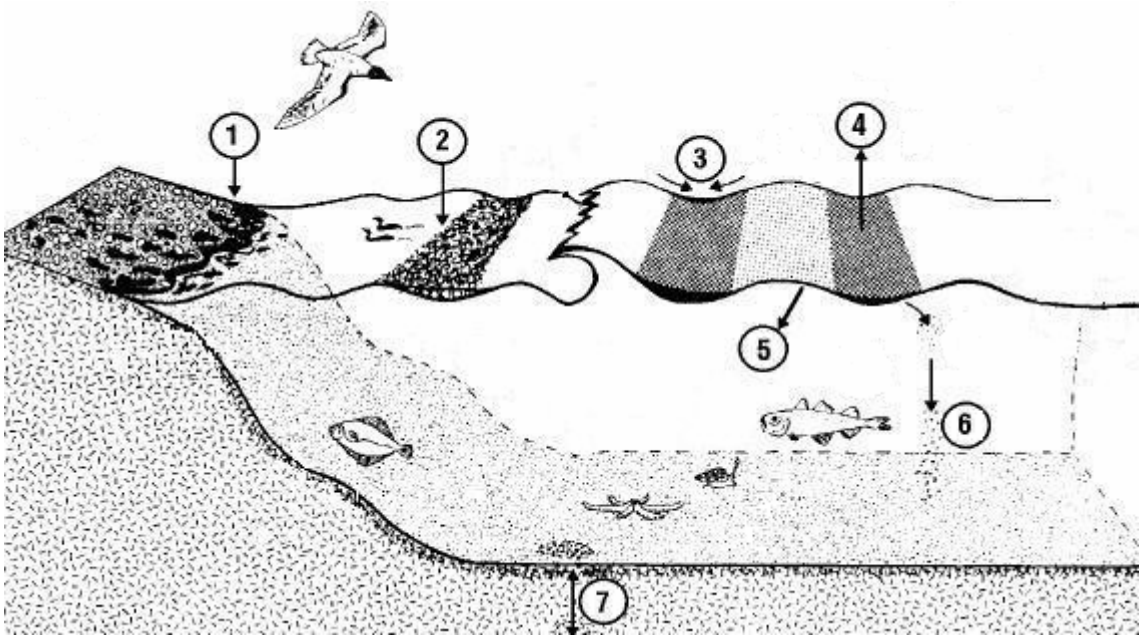


**Figure 21 The behaviour of oil in water**

### Oil spill on the beach

The first point illustrates oil that has washed ashore on the beach. Petroleum products released into the beach have an enormous impact on everything from animals to plants to people. For example, when birds come into contact with the petroleum it causes the birds to be intoxicated and rather often they die since they are unable to remove the oil from the feathers. The degradation of oil on the beaches is very slow and it can take more than ten years for the fauna to be recovered. Crude oil, which is thicker and stickier, is very adhesive to rocks on the beaches and requires wide-ranging sanitation methods.[157]

### Emulsification

Emulsification is illustrated by the second point in the picture and is the process by which one liquid is dispersed into another one in the form of small droplets. The emulsion of water-in-oil is in a stable form and the resulting material is very different from the oil product. The

[156] Fingas, 2001

[157] Fejes & Lindgren, 2003

mechanism of emulsion is not fully yet understood but it probably starts with sea energy forcing the entry into small water droplets. Once in the oil, the droplets slowly sink to the bottom of the oil layer. Asphaltenes and resins in the oil interact with the droplets and thus help to stabilize the emulsion. The increase in volume and viscosity caused by the emulsification make cleanup operations more difficult. Emulsified oil is difficult or impossible to disperse and also difficult to recover with skimmers or to burn. Semi-stable emulsions are relatively easy to break down, whereas stable emulsions may take months or years to break down naturally. [158]

**Spreading**

Point third illustrates the spreading of oil spills on water. The oil tends to spread into a thin slick over the water surface, which is especially true for lighter products such as gasoline, diesel fuel and light crude oils. Heavier oil types tend to form thicker layers and can also form tar balls. Wind and currents help to spread the oil out more quickly. However, even in the complete absence of wind and water currents oil tend to spread horizontally over the water surface. The spreading also depends upon the viscosity of the oil and the surface tension between oil and water. The surface tension helps to increase the spreading of the oil slicks. In general, an oil slick on water spreads relatively quickly after an oil spill. After a day or two, the effect of spreading is diminished. [159]

**Evaporation**

Point four illustrates the evaporation process and has a great effect on the amount of oil remaining on water or land after a spill. The rate of evaporation depends primarily on the composition of oil. Lighter oil types, such as gasoline, evaporate completely over a period of some days. In general, the more volatile components the oil contains, the greater the extent and rate of its evaporation. Many components of heavier oil types will not evaporate at all. The evaporation rate is very rapid immediately after a spill and is then slowed considerably. About 80% of evaporation occurs in the first few days after a spill. [160]

**Natural dispersion**

Natural dispersion is illustrated by point five and decreases the amount of oil on the water surface but increases the concentration of oil into the underlying water column. This

[158] Fingas, 2001
[159] Fingas, 2001
[160] Fingas, 2001

phenomenon occurs when fine droplets of oil are transferred into the water column by wave action or turbulence. Depending on oil conditions and the amount of sea energy, natural dispersion can be insignificant or it can remove the entire bulk of the oil. Heavy oil types such as crude oil will not disperse naturally to any significant extent, whereas lighter oil fractions can disperse significantly if the sea energy is high. [161]

**Sedimentation**

Sedimentation is illustrated by point six and is explained as the process by which oil is deposited on the bottom of the sea. Most sedimentation occurs when oil droplets reaches a higher density than water after interacting with minerals in the water. Once oil is on the bottom, it is usually covered by other sediment and degrades very slowly. Sedimentation does not generally play a significant role in most oil spills but can be harmful to the shoreline over the long term. [162]

**Biodegradation**

Point seven illustrates the process of biodegradation which is described as microorganisms that are capable of degrading petroleum hydrocarbons and other organic material in the nature. [163] The rate of biodegradation depends upon the nature of the hydrocarbons and on the temperature. Generally, the rate of biodegradation increases as the temperature increases. Biodegradation can be a very slow process for some oils. Under optimal conditions it can take weeks for 50% of diesel fuel and years for 10% of crude oil to biodegrade. For this reason, biodegradation is not considered to play an important role. [164]

[161] Fingas, 2001
[162] Fingas, 2001
[163] Fejes & Lindblom, 2003
[164] Fingas, 2001

## Appendix C – Environmental effects

The table below refers to Fejes and Lindbloms environmental assessment of absorbents[165]. It is different from the factors considered in the thesis since it was not possible to consider all the factors due to time and information constraints.

**Table 16 Environmental assessment by Fejes and Lindblom**

Bedömningskriterier

| **Bedömningsgrund** | **3** | **2** | **1** | **0** | **-1** |
|---|---|---|---|---|---|
| **Tilverkning och transport** | | | **Ja** | | **Nej** |
| Består sorbenten av en koldioxidneutral råvara? | | | 1 | | -1 |
| Är sorbenten tillverkad utan ändliga och förbjudna råvaror? | | | 1 | | -1 |
| Ingår sorbentmaterialet i ett naturligt kretslopp? | | | 1 | | -1 |
| Är sorbenten naturligt nedbrytbar? | | | 1 | | -1 |
| Medföljer ett detaljerat produktblad? | | | 1 | | -1 |
| Finns resultat från en förenklad LCA? | | | 1 | | -1 |
| **Sorbenters giftighet** | | | **Ja** | **Ja** | **Nej** |
| Är algtestet negativt (lakvatten ej giftigt för alger)? | | | 1 | | -1 |
| Om inte, är Microtox-testet negativt (lakvatten ej giftigt för bakterier)? | | | | 0 | -1 |
| Om inte, är fiskyngeltestet negativt (lakvatten ej giftigt för fiskyngel)? | | | | 0 | -1 |
| **Sorbtionskapacitet [g olja/mL sorbent]** | **>1** | **0,6-1** | **0,5-0,6** | | **<0,5** |
| Hur stor är sorbtionskapaciteten? | 3 | 2 | 1 | | -1 |

Bedömningskriterier. Fortsättning

| **Bedömningsgrund** | **3** | **2** | **1** | **0** | **-1** |
|---|---|---|---|---|---|
| **Arbetsmiljö** | | | **Ja** | | **Nej** |
| Finns hanteringsinstruktioner för saneringsarbete med rena sorbenter och hantering av oljehaltiga sorbenter? | | | 1 | | -1 |
| Finnas lista över vilka ämnen bildas vid brand av ren sorbent? | | | 1 | | -1 |
| Finns manual och/eller utbildningspaket som visar hur sorbenten skall hanteras? | | | 1 | | -1 |
| **Kvittblivning** | **Ja** | **Ja** | **Ja** | **Nej** | **Ja** |
| Kan förorenad sorbent återanvändas? | 3 | | | 0 | |
| Om inte, kan förorenad sorbent förbrännas? | | 2 | | 0 | |
| Om inte, kan förorenad sorbent komposteras? | | | 1 | 0 | |
| Måste förorenad sorbent deponeras? | | | | 0 | -1 |

165 Fejes & Lindblom, 2003

Considering *manufacturing and transportation*, the thesis do not consider if there is a result of a simplified LCA since this information could not be found for any of the studied products.

A test regarding the absorbents *toxicity* is not included in the thesis since it would be very demanding to carry out the test. Insufficient skills in percolorating of toxic substances and the inavailability of the necessary research equipment made this test impossible to conduct.

Regarding the *working environment*, we have a different approach to the working environment of absorbents since manuals and instructions are usually included in the package. However, an important aspect which is mentioned in other articles by Fejes is the usage of absorbents which explains how easy the absorbent is to handle[166].

Regarding the *destruction*, the absorbents in the thesis was not possible to re-use after absorption of oil and this aspect of the destruction is not included in the thesis. Incineration in a pan with chimney gas purification is usually regarded as the most environmental friendly method and therefore the other aspects are not included[167].

The table below shows the resulting score table of the analysis of the environmental effects conducted in the thesis. The point settings are different from Fejes and Lindbloms evaluation chart and the underlying reason is to present a comprehensive overview of the most important stages of the absorbents life cycle in an environmental perspective.

**Table 17 Evaluation chart of environmental effects**

| **Evaluation chart of environmental effects** | | | | | |
|---|---|---|---|---|---|
| Manufacturing | | | Yes | | No |
| Does the absorbent consist of carbon-neutral material? | | | 3 | | 0 |
| Does the absorbent consist of renewable material? | | | 3 | | 0 |
| Is the absorbent biodegradable? | | | 3 | | 0 |
| Is a detailed product sheet included? | | | 3 | | 0 |
| Absorption capacity [L oil/L absorbent] | >0.7 | 0.6-0.7 | 0.5-0.6 | 0.4-0.5 | <0.4 |
| How high is the absorptive capacity? | 5 | 4 | 3 | 2 | 0 |
| Usage | | | God | Average | Bad |
| How good is the absorbents capability of bearing? | | | 2 | 1 | 0 |
| How well is the resistance to crumbling? | | | 2 | 1 | 0 |
| How good is the absorbents saturation time? | | | 2 | 1 | 0 |
| How easy is to collect the absorbent after usage? | | | 2 | 1 | 0 |

166 Fejes et al, 1999

167 Fejes et al, 1999

| Destruction | Yes | Yes | No | Yes |
|---|---|---|---|---|
| Is it possible to incinerate polluted absorbents? | 7 | | 0 | |
| Are polluted absorbents deposited? | | | 3 | 0 |
| Summation | | | | **Σ x** |

**Manufacturing**
During the manufacturing process the most important characteristics are considered to be the material of the absorbent and the energy usage in the production process. Since it was impossible to gather data about the competitor's energy usage in their production process the energy usage is not included in the analysis. The material should not consist of petroleum products or other substances that are harmful for the society.

**Absorption capacity**
A product with a good absorptive capacity is more effective in the sanitation of oil spills. This product will thus decrease the harmful impact of the environment caused by the oil[168].

**Usage**
The net environmental impact resulting from the usage of the absorbents is the result from several important characteristics of the absorbents. Absorbents, which are not very good in this dimension will more easily disperse and break down into the surrounding environment[169]. These absorbents are consequently more harmful for the environment.

**Destruction**
The destruction is given the following prioritizing; destruction by incineration is considered to be better than destruction using composting. The reason for this prioritizing is because the heat energy can be gathered in the incineration process. Another reason is because is it difficult to make the composting process free of pollutions and the compost material must therefore be managed with caution. If the only way to threat used absorbent is to use deposition this is regarded as a not very environmental friendly method. [170]

[168] Fejes & Lindblom, 2003
[169] Fejes & Lindblom, 2003
[170] Fejes & Lindblom, 2003

## Appendix D – Guidelines for interviews with customers

**Oil spills**

What are the most common types of oil spills you deal with? Types of accidents? Frequency?

What different types of oil are most common in oil spills?

How do you try to prevent oil accidents?

What type of oil spills is most important for you to deal with?

**Sanitation**

Do other organizations help to cleanse oil spills?

Which oil types are most difficult to sanitate?

**Methods/products**

What types of oil sanitation methods or products do you use today?

Do you use any oil absorbent products? Which ones? Application areas?

What shape has the absorbents you use?

Do you use absorbents as a complement for other methods?

What are your opinions about synthetic and non-synthetic absorbents?

**Characteristics of absorbents**

What are the most important characteristics in an absorbent?

How price-sensitive are you when buying absorbents?

How important is the ecological impact of the absorbent? Destruction, Biodegradability?

Are there any characteristics that you think is not satisfied by your current products?

What expectations do you have for oil sanitation methods and products in the future?

How much money does your organization spend on absorbents each year? (Approximate)

# Appendix E – Production cost calculation

**Table 18 Production cost calculation**

**Year 1**

| **Production cost calculation** | Amount (SEK) | Cost unit | Explanation |
|---|---|---|---|
| Revenue | | | |
| Turnover | 1 000 000 | Price x Volume | 2.5 SEK x 400 000 L |
| Variable costs | | Volume dependant costs | |
| Raw material | -100 080 | Material cost x Volume | 2780 SEK/ton |
| Packaging | -15 000 | Material cost x Volume | 1.5 SEK / 40l bag |
| **Contribution margin 1** | 884 920 | | |
| | | | |
| Fixed costs | | | |
| Depreciation packing machine | -50 000 | Yearly depreciation | 5 years depreciation |
| Depreciation pulp dryer | -15 000 | Yearly depreciation | 5 years depreciation |
| Salary (two persons) | -930 000 | Yearly salary including taxes | |
| Marketing costs | -300 000 | Yearly costs for marketing | Cost for commercials, sales etc |
| Adminstration costs | -50 000 | Yearly costs for the administration | Cost for office supplies, rent etc |
| **Contribution margin 2** | -460 080 | | |
| Alternative cost | -90 720 | Alternative cost for the pulp | Profit from paper pulp |
| **Net profit** | -550 800 | | |

**Year 2**

| **Production cost calculation** | Amount (SEK) | Cost unit | Explanation |
|---|---|---|---|
| Revenue | | | |
| Turnover | 1 500 000 | Price x Volume | 2.5 SEK x 600 000 L |
| Variable costs | | Volume dependant costs | |
| Raw material | -150 120 | Material cost x Volume | 2780 SEK/ton |
| Packaging | -22 500 | Material cost x Volume | 1.5 SEK / 40l bag |
| **Contribution margin 1** | 1 327 380 | | |
| | | | |
| Fixed costs | | | |
| Depreciation packing machine | -50 000 | Yearly depreciation | 5 years depreciation |
| Depreciation pulp dryer | -15 000 | Yearly depreciation | 5 years depreciation |
| Salary (two persons) | -930 000 | Yearly salary including taxes | |
| Marketing costs | -200 000 | Yearly costs for marketing | Cost for commercials, sales etc |
| Adminstration costs | -50 000 | Yearly costs for the administration | Cost for office supplies, rent etc |
| **Contribution margin 2** | 82 380 | | |
| Alternative cost | -136 080 | Alternative cost for the pulp | Profit from paper pulp |
| **Net profit** | -53 700 | | |

**Year 3**

| **Production cost calculation** | Amount (SEK) | Cost unit | Explanation |
|---|---|---|---|
| Revenue | | | |
| Turnover | 2 000 000 | Price x Volume | 2.5 SEK x 800 000 L |
| Variable costs | | Volume dependant costs | |
| Raw material | -200 160 | Material cost x Volume | 2780 SEK/ton |
| Packaging | -30 000 | Material cost x Volume | 1.5 SEK / 40l bag |

| | | | |
|---|---|---|---|
| **Contribution margin 1** | 1 769 840 | | |
| | | | |
| Fixed costs | | | |
| Depreciation packing machine | -50 000 | Yearly depreciation | 5 years depreciation |
| Depreciation pulp dryer | -15 000 | Yearly depreciation | 5 years depreciation |
| Salary (two persons) | -930 000 | Yearly salary including taxes | |
| Marketing costs | -100 000 | Yearly costs for marketing | Cost for commercials, sales etc |
| Adminstration costs | -50 000 | Yearly costs for the administration | Cost for office supplies, rent etc |
| **Contribution margin 2** | 624 840 | | |
| Alternative cost | -181 440 | Alternative cost for the pulp | Profit from paper pulp |
| **Net profit** | 443 400 | | |

The costs for the raw material include the Norwegian total production costs for CTMP. The exchange rate the 12th of March was 1.19 SEK/NO and the resulting total cost for CTMP is 2780 SEK/ton. The quality of the pulp used is 650 CSF, which is rather low. The density of the fiber pellets is considered to be approximately 90g/l. The cost per liter will be 2.78 x 0.09 = 0.2502 SEK/l.[171]

Packaging costs include costs for a 40L bag without print and the cost is approximately 1.5 SEK/bag. The cost per liter will be 1.5 / 40 = 0.0375 SEK/l. [172]

The cost for the packaging machine is estimated to be 250 000 SEK. This is the price for the TBO Compact machine that is semiautomatic machine used to package bags. The TBO Compact machine is used for smaller production and is a product from Tecnoscan Processteknik. [173]

The rotating oven is considered to be a RO 1400 with an effect of 12kWh. The price of the oven is 75 000 SEK according to our source. [174]

The salary for one person includes a wage of 25 000 SEK/year including vacation payment (12% of the salary), social charges (32.42% of the salary including vacation payment) and contract insurance (6% of the salary including vacation payment) [175].

[171] Södra internal material, 2003
[172] Interview with Björn Karlsson, Tecnoscan Processteknik, 2008-03-12
[173] Interview with Björn Karlsson, Tecnoscan Processteknik, 2008-03-12
[174] Interview with Wilhelm Tham, Atham AB, 2008-03-14
[175] Rabe, 2008

Marketing costs include costs for brochures, marketing and sales is not be neglected and could be approximately 150 000 SEK/year. [176]

Administration costs often include rent for the locale, telephone bills, office supplies and other contingent expenditures. [177]

The price for CTMP is 880 dollars that is estimated to be around 6,02 SEK/dollar, which is 5 300 SEK/ton.[178] The alternative cost for ordinary CTMP production is 5300 – 2780 = 2520 SEK/ton that is 0, 2268 SEK/l. For 800 000 litres the alternative cost is 181 440 SEK. [179]

[176] Interview with Irené Ludvigsson, Ludvigsson Konsulter AB, 2008-03-13
[177] Interview with Irené Ludvigsson, Ludvigsson Konsulter AB, 2008-03-13
[178] www.paperage.com, 2008-03-13
[179] Södra internal material, 2003

## Appendix F – Approximate absorbent consumption

This chapter describes calculations of the approximate absorbent consumption of the studied segment.

### Concerned authorities

Since all actors in this segment was interviewed the absorbent consumption should be 160 000 + 25 000 = 185 000 SEK/year.

### Coastal Räddningstjänsten

Number of employees at Räddningstjänsten was 15 700 (full time and part time employment). [180] By using a statistical formula used to estimate amounts the approximated use of absorbents could be calculated. The total number of employees in the organizations interviewed was 2160.

$\sum X = n_{tot}/n_i \, (X_1 + X_2 + X_3 + \ldots + X_i)$[181]

$\sum X = (15\,700/2\,160)\,(80\,000 + 2\,300 + 7\,000 + 5\,000 + 12\,000) = 772\,643$ SEK/year.

Since only coastal Räddningstjänsten were interviewed the result is multiplied by the number of Räddningstjänsten divided by the total number of Räddningstjänsten in Sweden. [182]

$\sum Y = 772\,643 * (82/204) =$ approx. 311 000 SEK/year.

### Oil sanitation companies

Number of employees of the segment oil sanitation companies was estimated to be 4 500.[183] By using the same statistical formula as in the example from coastal Räddningstjänsten it is possible to estimate this segments consumption of absorbents. The total number of employees in the organizations interviewed was 2 195.

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180 www.raddningsverket.se, 2008-03-17

181 Milton & Arnold: Chapter 7, 2003

182 www.raddningsverket.se, 2008-03-20

$\sum X$ = (4 500/2 195) (75 000 + 20 000 + 1 000 + 5 000 + 15 000) = approx. 238 000 SEK/year.

**Oil harbours**

The total amount shipped oil to the harbours was estimated to be 52 884 thousand ton.[184] By using the same statistical formula as in the above examples it is possible to estimate this segments consumption of absorbents. The total amount of oil shipped in the organizations interviewed was 42 504.

$\sum X$ = (52 884/42 504) (4 000 + 20 000+ 84 000 + 45 000+ 15 000 + 0) = approx. 209 000 SEK/year.

**Oil shipping companies**

The total number of ships is estimated to be 75 according to Per Sjöberger at Svensk Redareförening. [185] The total number of ships in the organizations interviewed was 44 and the average absorption consumption was estimated to be approximately 200 SEK/ship. By multiplying the average consumption with the number of ships the total approximate absorbent consumption could be estimated.

$\sum X$ = 75 * 200 = 15 000 SEK/year.

**Refineries**

Since all actors in this segment was interviewed the absorbent consumption should be 5 000 + 5 000 + 1 000 + 9 000 + 5 000 = 25 000 SEK/year.

**Oil depots**

Since it was not possible to get access to information regarding the size of the depots or number of employees we are estimating the consumption of this segment to be the number of depots multiplied by the average consumption of the depots interviewed.[186]

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183 Appendix D, List of oil sanitation companies

184 Appendix D, list of oil harbours

185 Interview with Per Sjöberger, Svensk Redareförening, 2008-03-10

49 * (1/3) * (5 000 + 1 200 + 1 700) = approx. 129 000 SEK/year.

[186] Appendix D, list of oil depots

# Appendix G – Description of ASTM F 726 - 81

**Description of ASTM F 726 - 81 (Absorbents)**

The method is suited for tests of absorbents with different shapes. The method is applicable for absorption tests of oils and other organic fluids that floats on the water surface and does not mix (is soluble) in water. [187]

According to the description the absorbent is categorized into four types:

1. Material with a larger surface than thickness. (sheets, pads, nets, etc.)
2. Absorbents in the granular shape.
3. Enclosed absorbents in pads, booms, etc.
4. Agglomerated absorbents of for example string material, nets or other shapes, which give potential for an open structure. [188]

**Experimental conditions**

Equipment: Net baskets 20 x 20 $cm^2$ of screening material with a pore size of 45 μm.

Test fluid:

1. Shell Fuel oil No 1 with a density of 0,862 $g/cm^3$ for 20°C and a viscosity of 15 cSt.
2. Lube oil: A mixture of Shell Rimula 10 and Shell Rimula 30 (2:1) with a viscosity of 170 cSt for 20 °C and a density of 0,881 $g/cm^3$.

Temperature: 20 ± 1 °C.

Relative humidity: 50 ± 2 %, conditioning atleast 24 hours before test. [189]

**Experimental procedure**

1. The material of the absorbent was filled in the netbasket so that it cover the base with a thickness of 2 cm.
2. The basket was levered into the test fluid until the fluid covered the absorbent material. The time was measured when the fluid had penetrated all the material.

[187] Fejes et al., 1999

[188] Fejes et al., 1999

[189] Fejes et al., 1999

3. The basket was picked up after another 20 % of the measured time and redundant fluid flowed off for 30s (fluel oil) and 120s (lube oil).
4. The test was replicated three times and the result was reported as the average of the three experiments. [190]

The test was conducted by IVL institute in cooperation with SP in Borås. [191]

[190] Fejes et al., 1999

[191] Fejes et al., 1999