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Demonstrate and Assess Tools for Environmental Sustainability

Transport and the environment

Cellulosic Specialties in Örnsköldsvik and Stenungsund

Malin Bogeskär, Akzo Nobel

2002

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Abstract

The environmental impacts from transport to and from Akzo Nobel Surface Chemistry, Cellulosic Specialties, have been studied from a global and a local perspective. Only the part of Cellulosic Specialties producing EHEC and MEHEC (former Rheology Additives) is included in the study.

Large volumes of raw materials and products are transported to and from the site in Örnsköldsvik on a daily basis. This transport cause airborne emissions and depletion of energy resources. The study presents emissions of substances, of which the well known environmental effects are not further explained.

The global transport of goods to and from Örnsköldsvik caused total emissions of 3 700 tonnes of CO_2, 65 tonnes of NO_x, 4.0 tonnes of HC, 35 tonnes of SO_2 and 2.9 tonnes of CO in 2001. At the same time, 51 TJ of fossil energy was used. A comparison to the corresponding parameters for production of chemicals at the site in Örnsköldsvik shows that the transport is significant from an overall Cellulosic Specialties perspective. Approximately twice as much NO_x, four times as much CO and almost twice as much SO_2 were emitted from the transport in comparison to the production process. The amounts of CO_2 emitted from transport and production are quite similar.

To illustrate the environmental impacts from transport from a local perspective, the transport which takes place within a radius of 15 kilometres from the Örnsköldsvik site was studied. The result showed that 264 tonnes of CO_2, 778 kg NO_x, 194 kg HC, 2 kg SO_2 and 672 kg CO were emitted to the area defined above. If these emissions are compared to the total emissions in an average Swedish area with a radius of 15 kilometres, they are not significant. The employees journeys to and from work cause in most cases more negative environmental impacts than do the local transport of goods.

All in all, it must be concluded that the transport represents a significant share of the environmental impact caused by Cellulosic Specialties from a global perspective. Accordingly, it is important to make an effort to decrease the environmental impacts from transport and realize that this area is as important as working with environmental improvements directly connected to the production.

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1 Introduction

The purpose of this study is to highlight the environmental impacts from transport connected to Cellulosic Specialties, Akzo Nobel Surface Chemistry. To be able to contribute to a sustainable development, significant changes have to occur within the transport sector in general. Accordingly, it is important for Akzo Nobel to collect more information about the present situation to be able to act as active and responsible as possible in the development of society.

This study covers the environmental impacts connected to Cellulosic Specialties in Örnsköldsvik, but also the transport connected to employees at Cellulosic Specialties in Stenungsund. Transport caused by in- and outflows of goods to the site are included, as well as the employees' journeys to and from the workplace to their homes and site related transport.

Many environmental aspects in the production chain are not covered by the study. For example, it takes several transport and production units to distribute the final product to the consumer. In the life cycle, up stream Akzo Nobel's production site, there are several steps of extraction and refining of raw materials. These processes require energy and transport. When our products reach the consumers, they might cause different kinds of environmental impact during the use and disposal phases. All unit operations during the life cycle of a product will cause some kind of environmental impact.

A larger share of outgoing and a small share of the incoming transport are bought by Akzo Nobel. All relevant transport has been included in this study, no matter if bought by Akzo Nobel, a supplier or another party. For outgoing goods, the knowledge within the company about the final transport to the customer is poor. This is especially true for the distance to the customer from ports in other parts of the world. In such cases, assumptions have been made.

Data for volumes and destinations have been collected by those responsible for logistics and market. The data refer to volumes and transport during 2001. The choice of emission data is very important and may have a significant effect of the outcome of the study. The data originate from the Network for Transport and the Environment (NTM, [1]) and are commonly accepted to be of high quality. Further descriptions about underlying emission data can be found in Appendix I.

Environmental impacts from fuel production are included in all emissions data used for calculation of global transport. The fuel production process has not been included in the data used for local transport, since this process does not contribute to any local environmental impacts in Örnsköldsvik and Stenungsund.

2 The transport situation at Cellulosic Specialties

2.1 Transport of goods [2]

More than 100 different products sold in more than 80 different countries are manufactured at Cellulosic Specialties in Örnsköldsvik at present time. The raw materials are delivered from eight different countries, leading the overall transportation scenario to be rather complex.

	Outgoing products (tonnes)	**Ingoing raw materials (tonnes)**
Cellulosic Specialties 2001	15 300	27 300

Table 2-1 Transport flows in 2001.

A comparison of outgoing and ingoing volumes shows a difference. The reason is primarily the fact that large volumes of sodium hydroxide are lost with water effluents and that the chloride part of the raw material ethyl chloride forms salt, which cannot be sold as a product.

All production at Cellulosic Specialties takes place in Örnsköldsvik. From there, the products are transported either directly to their final destination by truck or, as most products, by truck or railroad to Gothenburg. In Gothenburg, the cargo is reloaded and further transported to Europe by truck or ship or to the rest of the world by ship. Transportation of goods by plane occurs seldom and is assumed to be negligible.

3 Global environmental impact

The major part of the transport connected to Cellulosic Specialties takes place globally, i.e. air emissions from the transport are spread all over the world. This is what is meant by global environmental impact in this report. However, this term should not be confused with the fact that some emissions affect the global environment and some others have their largest impact in the local environment where they take place. For example, CO_2 has no effect on a local level, but contributes to the global climate change wherever it is emitted. SO_2, on the other hand, has its most significant effect in the local area where the emission takes place. Therefore, CO_2 is equally harmful wherever it is emitted, while SO_2 is much more harmful in some environments than in others.

3.1 Transport work divided between different means of transport for goods

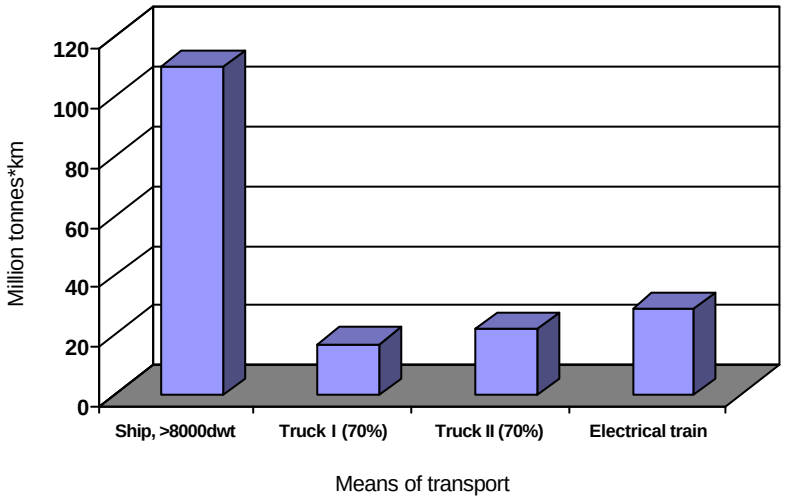

Diagram 3-1 Transport work for goods transport from and to Cellulosic Specialties, Örnsköldsvik, 2001

Above, the difference between Truck I and Truck II is the engine and the fuel. See Appendix I for more information about emission data.

The transport work is mainly carried out by ship (62%), but both trucks (22%) and electrical trains (16%) contribute with non-negligible parts. The total transport work for goods to and from Örnsköldsvik was 177 million tonnes*km in 2001.

3.2 Environmental impacts from different means of transport

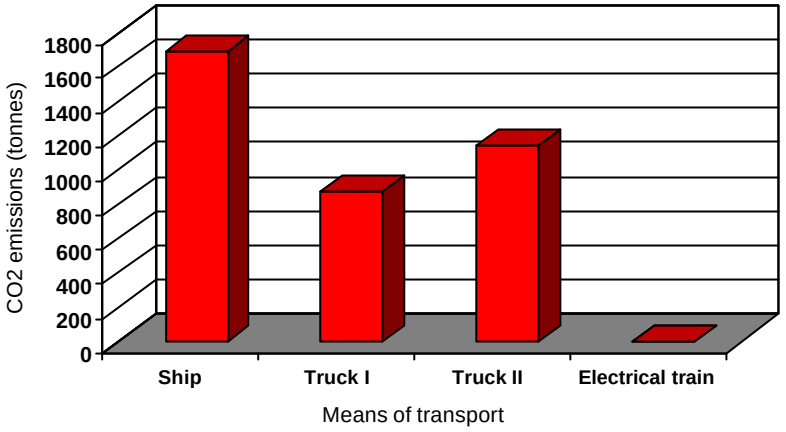

Diagram 3-2 CO_2 emissions from all global transport for Cellulosic Specialties in 2001

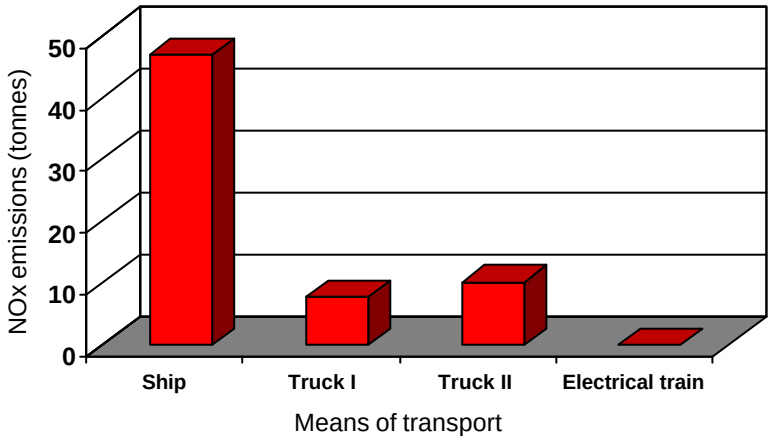

Diagram 3-3 NO_X emissions from all global transport for Cellulosic Specialties in 2001.

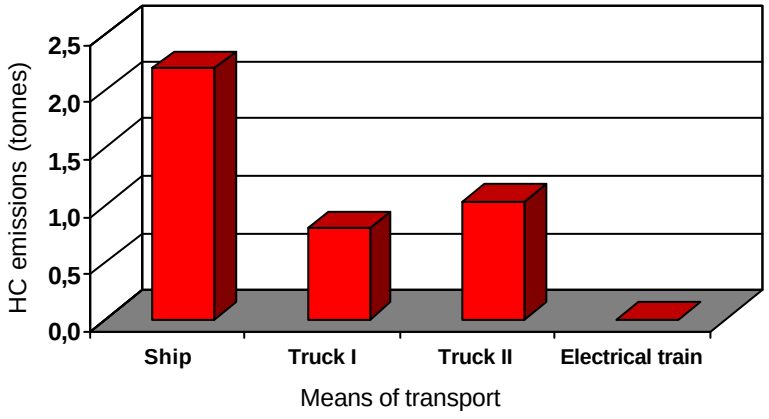

Diagram 3-4 HC emissions from all global transport for Cellulosic Specialties in 2001.

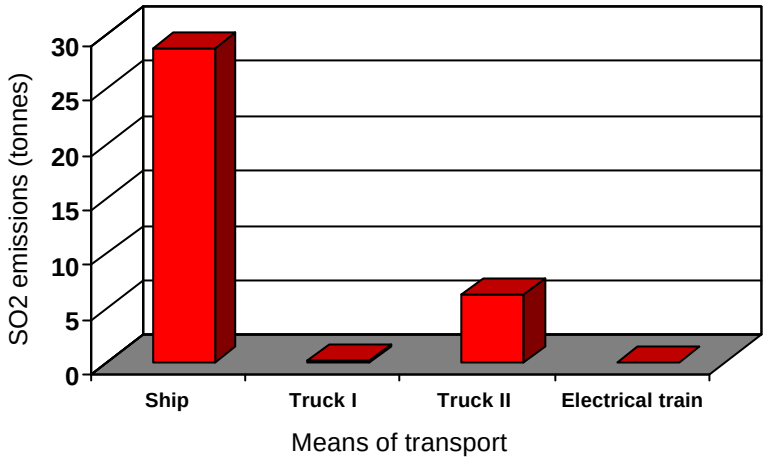

Diagram 3-5 SO_2 emissions from all global transport for Cellulosic Specialties in 2001.

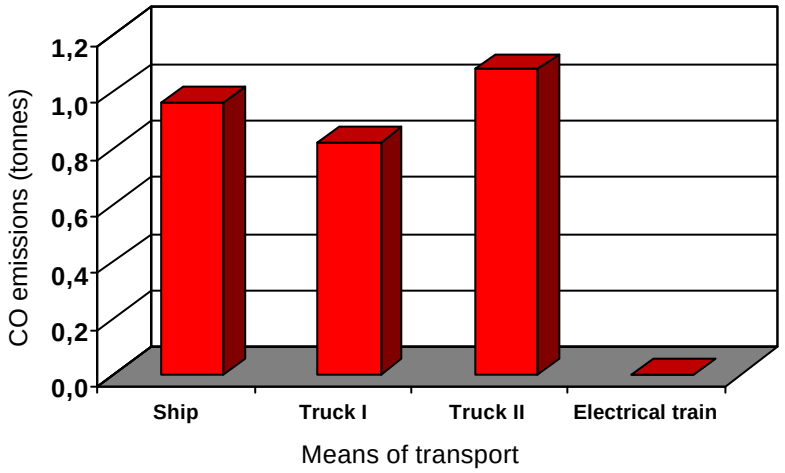

Diagram 3-6 CO emissions from all global transport for Cellulosic Specialties in 2001.

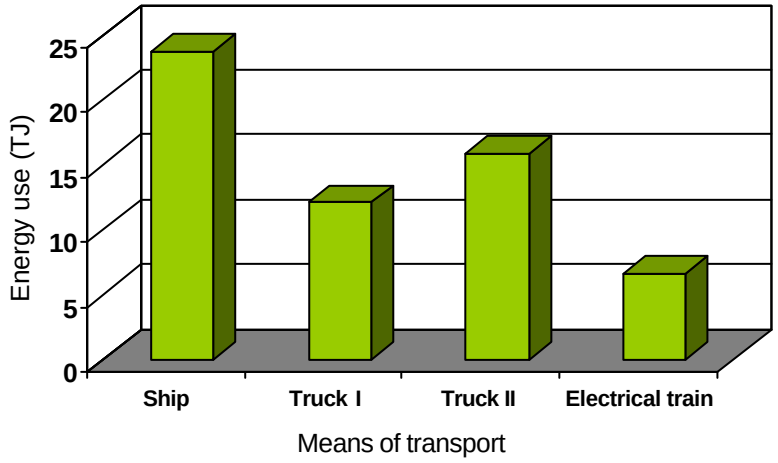

Diagram 3-7 Energy use for all global transport for Cellulosic Specialties in 2001.

The total emissions to air from global transport activities at Cellulosic Specialties were 3 700 tonnes of CO_2, 65 tonnes of NO_x, 4.0 tonnes of HC, 35 tonnes of SO_2 and 2.9 tonnes of CO in 2001. 51 TJ of fossil energy was used to transport goods. Almost 7 MJ of hydro power was used for railroad transport.

As indicated by the division of the transport work in part 3.1, the ship transport contributes the most to all environmental impacts. 45% of the CO_2, 72% of the NO_x, 55% of the HC, 83% of the SO_2 and 34% of the CO originate from ship transport. Also the longer truck transport (truck II) contributes significantly to all environmental impacts.

More information and emission data for the total global transport can be found in Appendix II.

3.3 The environmental impact of transport in comparison to production[3],[4],[5],[6]

A comparison of the site emissions from Cellulosic Specialties in Örnsköldsvik to the total transport emissions can be done in order to make a judgement of the relevance of the environmental impacts from the transport work.
4 100 tonnes of CO_2, 28 tonnes of NO_x, 37 tonnes of HC, 21 tonnes of SO_2 and 0.83 tonnes of CO were emitted from the production facilities at Cellulosic Specialties in Örnsköldsvik in 2001. The emissions originate from production of steam, which is bought from a local distributor, and from certain steps in the production process (HC only).

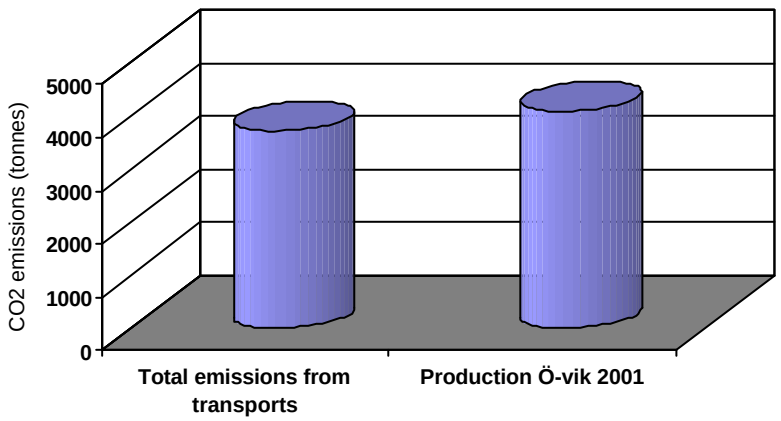

Diagram 3-8 CO_2 emissions from all transport in comparison to Örnsköldsvik site emissions in 2001.

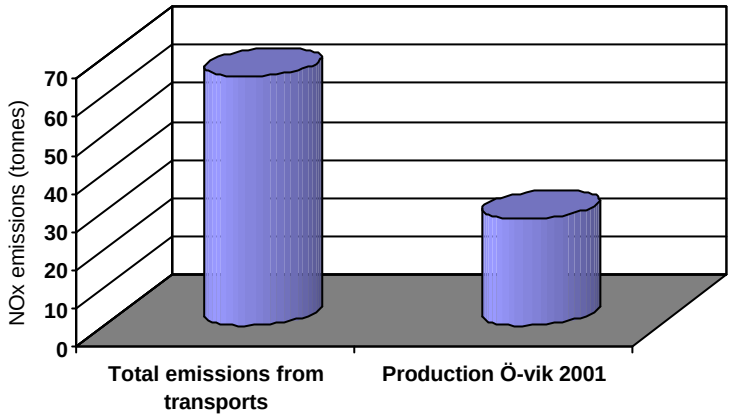

Diagram 3-9 NO_x emissions from all transport in comparison to Örnsköldsvik site emissions in 2001.

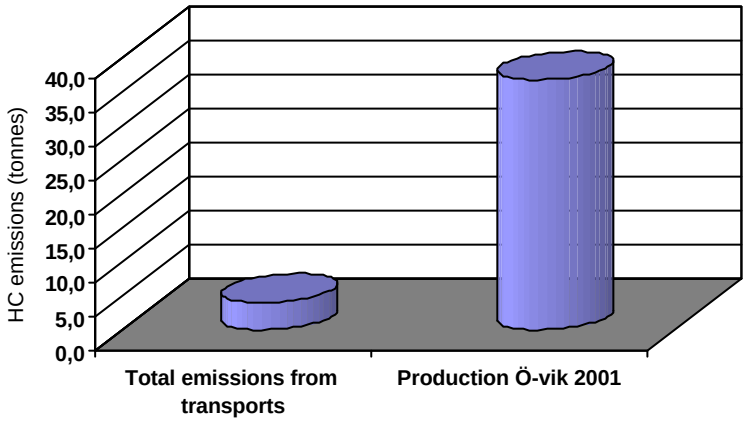

Diagram 3-10 HC emissions from all transport in comparison to Örnsköldsvik site emissions in 2001.

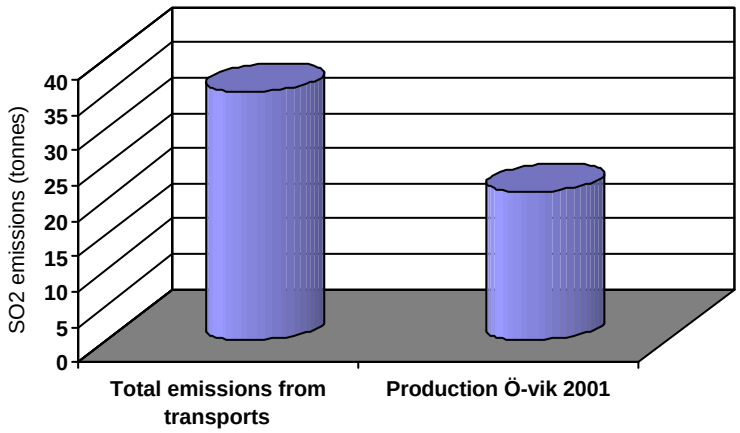

Diagram 3-11 SO_2 emissions from all transport in comparison to Örnsköldsvik site emissions in 2001.

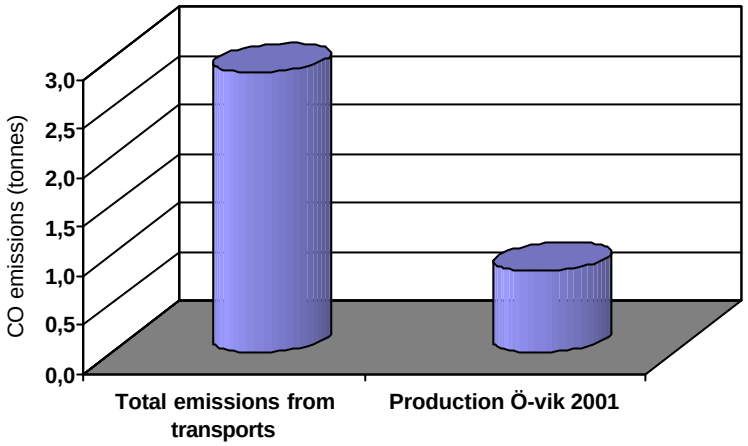

Diagram 3-12 CO emissions from all transport in comparison to Örnsköldsvik site emissions in 2001.

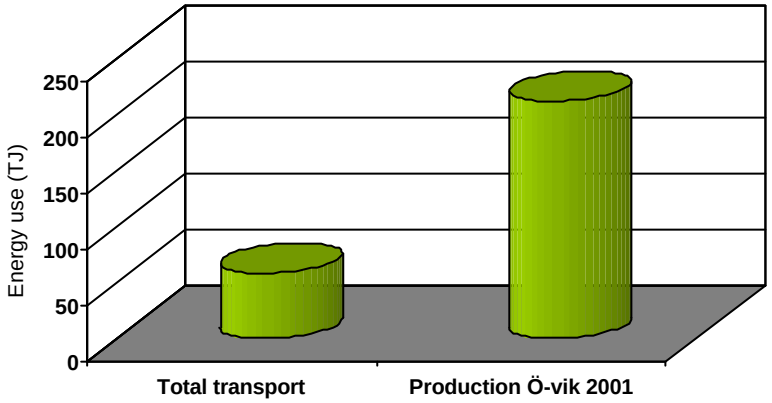

Diagram 3-13 Energy use for all transport in comparison to energy use at the site in Örnsköldsvik in 2001.

The only type of substance that is emitted in larger quantities from the production site is hydrocarbon emissions. Hydrocarbons from the production site are not only emitted from the steam production process, but also from the actual production.

All other types of the studied substances are emitted in larger quantities from the transport than from the production site except for CO_2, which is emitted in similar quantities. However, the energy use is about four times as high for the production as for the total transport work, indicating that the emissions per energy unit are much higher for most means of transport than they are for steam production. The reason for this is that all fuels used for transport originate from fossil resources, except for the electricity used by trains. 30% of the energy source for steam production originates from fossil resources, the rest is bio fuel. Bio fuels cause no emissions of CO_2 when combusted. The bio fuel/fossil fuel mix for steam generation also contains much less sulphur than the fuel used for ship and truck (II) transport. Another reason is that the combustion at the steam production facility is more controlled than the combustion process in a ship engine or in an old truck.

4 Local environmental impact

The environmental impacts arising from transport flows to and from Cellulosic Specialties can be viewed from different perspectives. One is the global perspective, where all transport is considered, no matter where they take place in the world. This scenario has already been described in chapter 3. Another perspective is the local one. In this case, an area with a radius of 15 km from the Örnsköldsvik centre has been considered. To incorporate all the local environmental impact, employees' journeys to and from the workplace have been considered as well as the impact from industrial trucks and other working machines at the production site. Some journeys to work are slightly longer than 15 kilometres, but this fact is considered negligible.

4.1 Local transport of goods [2]

The local transport is defined as the trucks which transport goods to and from the Gothenburg port or to and from suppliers in Sweden and the rest of Europe. The emission factors which are used to calculate the environmental impacts from local transport are slightly different from the ones chosen for the global transport. Additional information about emission factors can be found in Appendix I.

4.2 Passenger transport, industrial trucks and working machines compared to transport of goods [3],[4],[7]

Raw data for calculations of local environmental impacts from the employees' journeys to and from work as well as data for industrial trucks and other working machines can be found in Appendix IV and V.

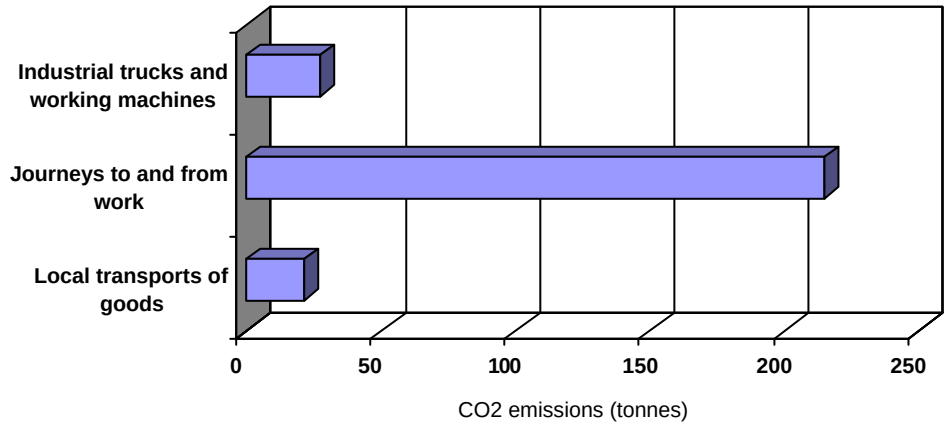

Diagram 4-1 CO_2 emissions from local transport connected to Cellulosic Specialties in 2001

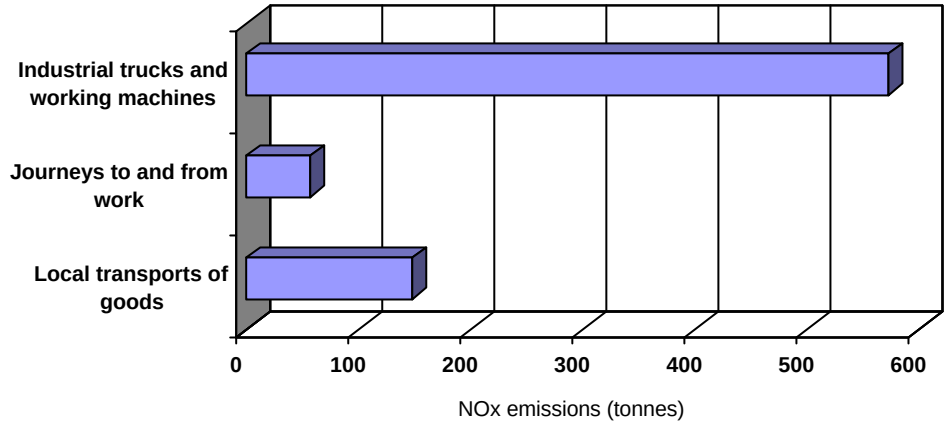

Diagram 4-2 NO_X emissions from local transport connected to Cellulosic Specialties in 2001.

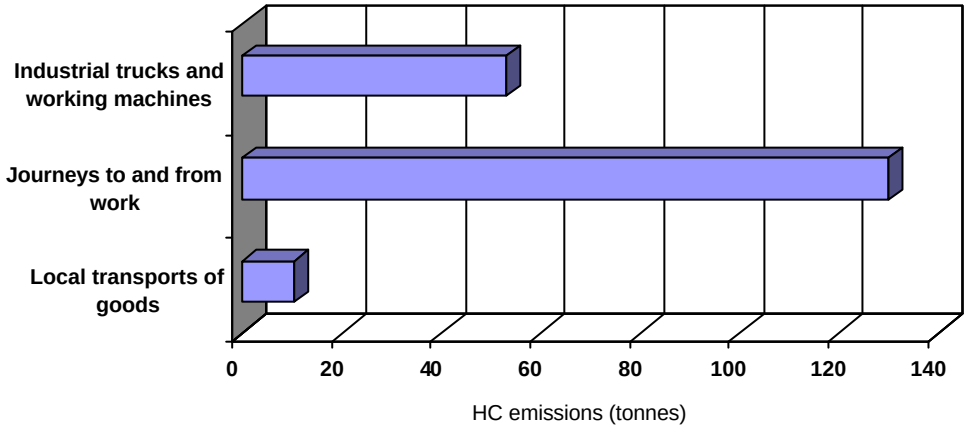

Diagram 4-3 HC emissions from local transport connected to Cellulosic Specialties in 2001.

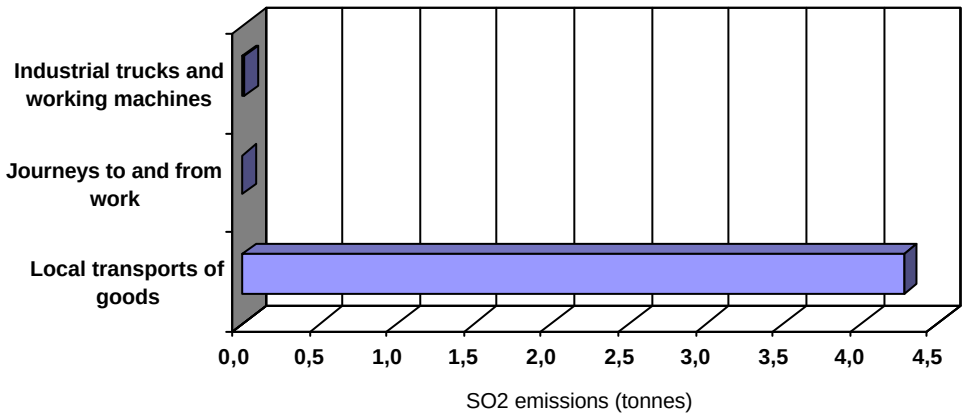

Diagram 4-4 SO_2 emissions from local transport connected to Cellulosic Specialties in 2001.

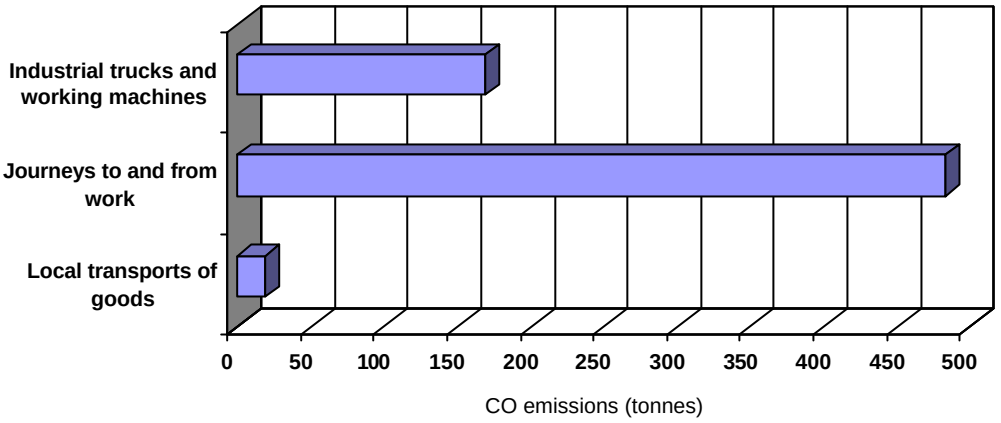

Diagram 4-5 CO emissions from local transport connected to Cellulosic Specialties in 2001.

All in all, 260 tonnes of CO_2, 778 kg NO_x, 194 kg HC, 2 kg SO_2 and 672 kg CO were emitted from Cellulosic Specialties transport in the Örnsköldsvik area in 2001.

The largest contributor to all types of emissions except for SO_2 was the employees' journeys to and from work. In a smaller city like Örnsköldsvik, the easiest way to get to work is by car and it is quite common that such journeys are carried out with only one person in the car. From an environmental perspective, this is a very inefficient way of travelling. However, gasoline has a very small content of sulphur, why the contribution to the SO_2 emissions from journeys to and from work is insignificant. Since some goods transport to Örnsköldsvik are carried out by trucks with MK3 diesel, with a much higher sulphur content than gasoline and diesel used for industrial trucks and other working machines, the transport of goods is the largest contributor to the SO_2 emissions.

More detailed information about emissions factors for local transport can be found in Appendix I.

4.3 Local transport in comparison to other local impacts[10]

If the total annual emissions of CO_2, NO_x and HC in Sweden are allocated to an area basis, it is possible to allocate a certain environmental impact to the local area of Örnsköldsvik, or any other area in Sweden, defined by a 15 kilometre radius. For city regions, this average is most likely lower than the actual emissions. For uninhabited areas, the real emissions are probably much lower than the average.

Anyway, the local emissions from transport connected to Cellulosic Specialties in Örnsköldsvik can be compared to the average total amount of local emissions in the same area. Even if these total emissions may be different in reality, the comparison will still show whether the emissions generated from Cellulosic Specialties may be significant from an overall perspective.

	Emissions from local transport, Cellulosic Specialties (tonnes)	Total emissions in a local area with a radius of 15 km (tonnes)	Cellulosic Specialties transport share of total emissions (%)
CO_2	270	110 000	0,2
NO_X	0.84	530	0,2
SO_2	0,004	150	0,003

Table 4-1 Comparison of local emissions for transport connected to Cellulosic Specialties to the total emissions in the Örnsköldsvik area.

Only a small share of the total emissions in the Örnsköldsvik area is likely to come from the transport connected to Cellulosic Specialties. The real share is probably less than shown in the table above.

5 Discussion

5.1 The global perspective

The environmental impacts from all transport to and from Cellulosic Specialties in Örnsköldsvik and in Stenungsund are significant. The most common emissions from combustion are similar or larger for the total transport than from the production site in Örnsköldsvik. Accordingly, it is important to make an effort to decrease the environmental impacts from transport and realize that this area is as important as working with environmental improvements directly connected to the production.

As touched upon in chapter 3, different air emissions cause different kinds of damage depending on where the emissions take place. For example, SO_2 is not as harmful when emitted by ships off-shore as when the emissions take place in areas sensitive to acidification, like the Swedish west coast. Hydrocarbon emissions cause more damage under certain temperature conditions and in sunlight, since these conditions are favourable for the creation of ground level ozone, which is toxic to flora and fauna. This kind of knowledge is important to apply when taking measures for environmental improvements.

5.2 The local perspective

The local environmental impacts from transport connected to Cellulosic Specialties in Örnsköldsvik are not considered significant in comparison to other local activities in the area. The local transport of goods is from many aspects less significant than the impact from employees' journeys to and from work or the impact from industrial trucks and other working machines.

In this context, it is however important to notice that individual exposure to emissions from maintenance and other handling of working machines by employees or exposure to certain emissions by residents from idling etc. are not accounted for in the study.

5.3 Future environmental impact

Doubling the production volume in Örnsköldsvik to approximately 30 000 tonnes would probably affect the relation between the environmental impacts from transport and production. Many factors are involved and it is hard to predict to what magnitude they would affect the total environmental impact. An increase of the volume of outgoing products would still allow for an extensive transport work to be carried out on railroad in Sweden, especially since the Botnia track will be in use from 2008. However, most of the outgoing transport work will still be carried out by trucks and ships outside Sweden. The fuels used by these means of transport will slowly grow cleaner, as the sulphur content of the fuels will decrease and the engines will be more efficient with respect to emission levels and fuel consumption. At the same time, some of the raw material transport per unit of raw material might increase, since a possible production increase will require larger raw material inputs than present suppliers are able to deliver. Additional raw materials will be bought from outside Europe, probably from Asia.

References

[1] NTM – Nätverket för Transporter och Miljön http://www.ntm.a.se/ ; 2002

[2] Karin Gustavsson, Cellulosic Specialties, Stenungsund, 2002

[3] "Miljörapport 2001, Akzo Nobel Surface Chemistry AB, Cellulosic Specialties, Produktionsanläggning i Örnsköldsvik", 2001

[4] Karin Nytorp, Akzo Nobel Surface Chemistry AB, Cellulosic Specialties, 2002

[5] Lisa Wedin, Akzo Nobel Surface Chemistry AB, Cellulosic Specialties, 2002

[6] Anders Berglund, MoDo Paper AB, Örnsköldsvik, 2001

[7] Human Resources, Akzo Nobel Surface Chemistry, 2002

[8] Marcus Wendin, Miljö och Kemi, Volvo Teknisk Utveckling AB, 2001

[9] Berg Staffan, "Emissioner till luft från fossila bränslen i svenskt skogsbruk"; 1996

[10] www.scb.se, 2002

Appendices

Appendix I	-	Emissions factors
Appendix II	-	Global environmental impacts
Appendix III	-	Local environmental impacts
Appendix IV	-	Journeys to and from work
Appendix V	-	Environmental impacts from production and site transport in Örnsköldsvik

Appendix I: Emission factors

Emission factors used to calculate global environmental impact						
Total emissions/ energy use (fuel prod. included)	**Ship, >8000 dwt, 50-60% filling coeff.**	**Truck I, 40 tonnes, 70% filling coeff., diesel MK1**	**Truck II, 40 tonnes, 70% filling coeff., diesel MK3**	**Electrical system train, 46% filling coeff. (SJ="green" el.)**	**Diesel train (Europe), 50% filling coeff., diesel MK3**	**Unit**
CO_2	15	52	52	0,004	19	g/tonne*km
NO_X	0,4	0,5	0,5	0,00001	0,4	g/tonne*km
HC	0,02	0,05	0,05	0,00001	0,02	g/tonne*km
Particles	0,02	0,007	0,007	0,000001	0,01	g/tonne*km
CO	0,01	0,05	0,05	0,0001	0,03	g/tonne*km
SO_2	0,3	0,01	0,3	0,000006	0,007	g/tonne*km
Energy use	0,2	0,7	0,7	0,2	0,2	MJ/tonne*km

Emission factors used to calculate local environmental impact						
Total emission/ energy use (fuel prod. not included)	**Ships are not used locally**	**Truck I, 40 tonnes, 50% filling coeff., diesel MK1**	**Truck II, 40 tonnes, 50% filling coeff., diesel MK3**	**Electrical trains have no local env. impacts**	**Diesel trains are not used locally**	**Unit**
CO_2		76	76			g/tonne*km
NO_X		0,5	0,7			g/tonne*km
HC		0,04	0,04			g/tonne*km
Particles		0,008	0,010			g/tonne*km
CO		0,07	0,07			g/tonne*km
SO_2		0,0001	0,02			g/tonne*km
Energy use		1,0	1,0			MJ/tonne*km

Appendix I: Emission factors

Choice of transport data

Global transportation:
Ship: Ship transportation is carried out primarily by smaller ships (3000-9000 dwt) to and from European ports. The longer transports are carried out with smaller ships between ports in Europe. The goods are then reloaded on to much bigger ships (up to 300 000 dwt) for the part of the transport which is carried out outside Europe [2]. The bigger ship represent more than 80% of the ship transports with respect to amount of tonnes*km. Accordingly, data for ships larger than 8000 dwt are assumed to be representative for all global ship transports.

Truck I (70% filling coefficient): Transports between Ö-vik (for further transportation by sea and reloading to other trucks) and Gothenburg are carried out primarily with truck carriers on railroad. Other transports within Sweded are carried out almost exclusively with trucks equipped by Euro 3 engines and MK1 diesel fuel. The filling coefficient of 70% is representative for average Swedish truck transports.

Truck II (70% filling coefficient):This type of truck and filling coefficient is typical for European truck transports. Euro2 engines and MK3 diesel fuel are assumed.

Electrical train: Transports within Sweden with SJ are connected to a low environmental load since all SJ train run on "green" electricity (hydro power electricity).

Diesel train: Approximately 15% of all all railroad transports in contintental Europe are carried out by diesel trains.

Environmental impacts from fuel production have been accounted for in all data which are used to calculate the total transport work, no matter where it has taken place.

Local transportation:

Truck I (50% filling coefficient): Within the Ö-vik area, the trucks are assumed to carry no cargo during the transport to OR from the site.

Truck II (50% filling coefficient): Within the Ö-vik area, the trucks are assumed to carry no cargo during the transport to OR from the site.

Idling or cold start have not been accounted for. Such circumstances would be very hard to make assumptions for. On the other hand, local transports are assumed to be carried out under worse driving conditions than long distance transports.

Environmental impacts from fuel production have not been accounted for in local transport data, since the fuel production activites do not take place locally.

NTM [1] is the data source for all above transportation data.

Appendix II: Global environmental impacts

Total emissions from transport, Cellulosic Specialties 2001	Ship	Truck I	Truck II	Electrical train	Total emissions from transport	Production Örnsköldsvik 2001	Unit
CO2	1689	871	1145	0,10	3705	4080	tonnes/yr
NOX	47	8	10	0,00034	65	28	tonnes/yr
HC	2,2	0,8	1,0	0,00034	4,0	37	tonnes/yr
CO	1,0	0,8	1,1	0,0026	2,9	1,6	tonnes/yr
SO2	29	0	6	0,00017	35	0,8	tonnes/yr
Energy use	24	12	16	7	58	21	TJ/yr

Appendix III: Local environmental impact from transport

Trp of goods			
Type of emission	Truck I (50%), 40 tonnes, diesel MK1	Truck II (50%), 40 tonnes, diesel MK3	Total Örnsköldsvik (kg/yr)
CO_2	14072	13556	27628
NO_X	86	120	206
HC	7	7	14
Particles	1	2	3
CO	13	13	26
SO_2	0	4	4
Energy use	188	181	368

Cellulosic Specialties 2001	Local transports of goods	Employees' journeys to and from work, STS	Employees' travel to and from work, Örnsköldsvik	Journeys to and from work	Industrial trucks and working machines	Total emissions/ energy use	Unit
CO_2	28	46	170	215	28	**270**	tonnes/yr
NO_X	206	12	45	57	573	**836**	kg/yr
HC	14	27	102	130	53	**197**	kg/yr
Particles	3	0	0	0	11	**15**	kg/yr
CO	26	102	381	483	170	**678**	kg/yr
SO_2	4,3	0,0	0,0	0,0	0	**4**	kg/yr
Energy use	368	151	562	713	383	**1464**	GJ/yr

Cellulosic Specialties, Ö-vik, local environmental impacts:

Ship: All shipping is carried out from Gothenburg, i.e. no local environmental impact arises from ship transports.

Truck I: Truck transports in Sweden.

Truck II: Truck transports in the rest of the world.

Electrical train: The main part of the transport between Gothenburg and Ö-vik is carried out by train.

Appendix IV: Journeys to and from work, Cellulosic Specialties employees in Örnsköldsvik and Stenungsund

Journeys to and from work, Cellulosic Specialties, Stenungsund					
Area code	**Area**	**Number of employees**	**Distance, round trip (km)**	**Percentage by car**	**Distance per yr, site area (km)**
41XXX, 42XXX & 43XXX	Gothenburg area	18	110	80%	97200
444XX	Stenungsund area	6	22	80%	23760
444XX	Stenungsund town	24	5	60%	16200
449XX	Nödinge	1	44	80%	5400
471XX	Tjörn	2	32	80%	10800
472XX, 473XX & 474XX	Orust	6	44	80%	32400
Total		**57**			**185760**

Journeys to and from work, Cellulosic Specialties, Örnsköldsvik					
Area code	**Area**	**Number of employees**	**Distance, round trip (km)**	**Percentage by car**	**Distance per yr, site area (km)**
890XX	Björna	5	74	90%	74925
890XX	Husum	1	54	90%	10935
890XX	Mellansel	5	64	90%	64800
891XX	Arnäsvall	5	10	90%	10125
891XX	Bonässund	9	16	90%	29160
891XX	Järved	5	16	90%	16200
891XX	Örnsköldsvik	51	8	80%	73440
892XX	Domsjö	67	5	60%	45225
893XX	Bjästa (köpmanholmen	20	36	90%	145800
893XX	Sidensjö	2	60	90%	24300
894XX	Moliden	2	40	90%	16200
894XX	Själevad	16	8	90%	25920
894XX	Överhörsnäs	6	16	90%	19440
895XX	Bredbyn	8	84	90%	136080
Total		**202**			**692550**

Appendix IV: Journeys to and from work, Cellulosic Specialties employees in Örnsköldsvik and Stenungsund

Journeys to and from work				
Emissions (g/km)		**Emissions per yr, CS employees total (kg)**	**Emissions per yr, site STS area (kg)**	**Emissions per yr, site Örnsköldsvik area (kg)**
CO_2	245	215186	45511	169675
NO_X	0,065	57	12	45
HC	0,148	130	27	102
Partiklar	0	0	0	0
CO	0,55	483	102	381
SO_2	0	0	0	0
Energy use (kWh/km)	0,8	713	151	562

Journeys to and from work:
Residential areas have been obtained through area codes in employee files. Employees equal all employees at Rheology Additives in Stenungsund and Örnsköldsvik,
Employees are assumed to travel to and from work 225 days per year.
Travel routes have been estimated with road database program Route LogiX.
"Site area" equals an area with a 15 kilometre with the site as a centre.
All employees travel to and from site Ö-vik are resident within the Ö-vik municipality.
The travel pattern of the employees have been estimated from a random selection of 20 employee travel patterns. Car pool and use of other transport means have been considered. Data for air emissions are represented by data from a gasoline driven Volvo V70. This a common car model, but it is probably slightly bigger than the average car. This is compensated by the fact that the V70 in the study is a new model and, therefore, it probably causes lower emissions than the average car. The data have been collected directly from Volvo [10].
Environmental impacts from fuel production are not included, since this process do not take place locally.

Appendix V: Environmental impacts from production and site transports in Örnsköldsvik

Industrial trucks and other working machines	Emissions/MJ diesel (g)	Emissions/litre diesel (g)	Emissions per yr (kg)
CO_2	72,3	2611	27682
NO_X	1,5	54	573
HC	0,14	5,0	53
Partiklar	0,03	1,1	11
CO	0,44	16	170
SO_2	0,00004	0,002	0,016
Energy use (kWh)			106294

Industrial trucks and other working machines

10,6 m3 diesel was consumed in at Cellulosic Specialties in Ö-vik 2001 [4]. The major part of the diesel was consumed by industrial trucks and other on-site working machines.

Emissions data for diesel combustion are valid for forestry machines, but according to [9], the emission factor can be used as an approximation for industrial trucks and other working machines. The emission factor for SO2 has been adjusted to be valid for MK1 diesel (max 10 ppm sulphur). Assumed heat value for diesel is 36,1 MJ/litre. Emissions from fuel production is not included, since this activity does not contribute to any local environmental impact.

Site Örnsköldsvik 2001	Emissions from steam (g/MJ)	Other emissions (tonnes/yr)	Total emissions (tonnes/yr)/ Energy use (kWh/yr)
CO_2	19,24		4080
NO_X	0,131		28
HC	0,00104	36,4	37
Partiklar	0,0076		2
CO	0,0039		1
SO_2	0,099		21
Energy use (kWh)			58900000

Ö-vik on site emissions:

Electricity and steam are used as energy carriers in Ö-vik. Since the emissions from electricity production do no affect the local environment i Ö-vik, these emissions have not been accounted for. The steam, however not produced on site, is bought from a local source. Accordingly, the emissions from steam production have been accounted for. The steam consumption was equal to 58,9 GWh in 2001.

From the actual production site, no other emissions than hydrocarbons have been accounted for.