ANALYSIS OF ALTERNATIVES

non-confidential report

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1 SUMMARY

The present document analyses potential alternative substances for Trichloroethylene (TRI) in the production process of Alcantara®. Alcantara® is a material composed of about 70% polyester (polyethylene terephthalate (PET)) and 30% polyurethane. This high-tech fibre has a broad field of applications in, for instance, the automotive sector, interior designs, but also fashion. The production company ALCANTARA uses TRI to extract polystyrene from an intermediate product of the material.

37 solvents were examined for feasibility to replace TRI with focus on technical feasibility. On the basis of chemical's ability to solubilise polystyrene, but not to attack PET, a first assessment of the chemicals was conducted. The current production process includes the recovery of TRI by evaporation for reuse. Therefore, boiling point and flammability were further critical technical criteria that were closely linked to economic feasibility since machinery will need to be adapted in case the solvent of choice does not meet these criteria. None of the selected 37 chemicals fulfilled these required intrinsic chemical and physical characteristics. Comprehensive laboratory testing of pre-selected solvents was avoided since ALCANTARA envisages the implementation of an alternative process that replaces the use of TRI and also Dimethylformamide (DMF), another SVHC used in another process step. A change of raw materials and adaption of process steps makes this replacement possible. Instead of polystyrene, an anionic co-polyester named Alkali Soluble polyester (ASP) is used. ASP will be removed with a hot aqueous solution of an alkalic substance, Sodium Hydroxide (NaOH). This makes the removal of Polystyrene (PST) by TRI no longer be required due to the presence of the new raw material ASP. DMF is currently used for synthesizing polyurethane (PU), a chemical that serves for impregnation of the material. By employing a polyurethane solution in water (PUR) instead of synthesis of PU, the use of DMF will not be necessary anymore. This so-called Future ALCANTARA Non Solvent (FANS) project is in a pilot stage at the moment. The whole project foresees the installation of production lines running on a basis of the new production technique in parallel to the old production lines (with TRI and DMF). This way, the production output of the FANS process shall stepwise reach the extent of today's production output. The old production lines would be replaced completely. The installation of the FANS technique is accompanied by customer approval which is necessary for 86% of the sold products. A full replacement of the current production process is planned in 2024.

Both the current and the future production processes at ALCANTARA are innovations that represent an intellectual property. In order to protect commercial interests including the intellectual property, insides about certain raw materials, process techniques and related investment costs have been claimed confidential throughout this document.
2 ANALYSIS OF SUBSTANCE FUNCTION

2.1 Alcantara®

ALCANTARA develops, manufactures and sells a homonymous composite material called Alcantara®. Alcantara® is an Blank #1 material composed of about 70% polyester and 30% polyurethane, whereas the term polyester refers to the substance polyethylene terephthalate (PET). Alcantara® is a high-tech material and is used by final article assemblers to cover surfaces and forms in a broad range of applications. According to the company's information, Alcantara® is based on a unique proprietary technology and represents an innovative and exclusive product.

Alcantara® has four different fields of application according to the company's sustainability report from 2012 (1):

a) Automotive: the product is used to cover the interiors of motor vehicles in the car industry. For instance, Alcantara® is used on seats, door panels among other parts of the car.

b) Interior, Contract & Yachting: items of furniture as sofas, beds, lamps and walls are covered with Alcantara® in the Interior and Yachting industry. Contract customers (usually public areas, hotels, etc) include architecture and design firms or specialized firms (contractors).

c) Fashion and accessories: fashion brands use Alcantara® for manufacturing clothes, bags, hats, shoes and belts.

d) Consumer electronics: ALCANTARA offers customized solutions for accessories of electronic devices. Examples of accessories made of Alcantara® are cases for tablets, cell-phones, cameras, audio and video devices.

The solvent TRI (Trichloroethylene) is used during one step of the production process for removing polystyrene from an intermediate product which is described in the following section. Analysis of the endproduct showed no detectable TRI-residues, please see the annexed document (analytical report) in section Fehler! Verweisquelle konnte nicht gefunden werden..

2.2 Description of the process

The following process description can be found in a more detailed way in the ES. Process steps requiring TRI are related to the worker contributing scenarios in the ES.

2.2.1 Production of the material

ALCANTARA’s production process comprises of five different steps, starting with the production of fibre through the mixture of polyethylene terephthalate (PET), polystyrene (PST) as main components and polyethylene glycol as an additive see Figure 1. Through extrusion, together with a high temperature and pressure, a very thin filament composed of Blank #1 fibres from PET (0.1 denier diameter) are obtained. Denier is a textile unit to measure linear mass density of fibres and
expresses the mass in grams per 9000 meters. Polystyrene (PST) is used to combine these microfibres and make thicker fibres out of them. This is necessary in order to protect the fibres from physical stress and make them processible in the following steps. These thicker fibres are further treated with lubricant agents. After that, the fibres' thinness is enhanced through ironing and drying. Subsequently, the filaments are cut, packed and sent to the second part of the process, where the felt is produced. This step is based on two processes- carding and needling. The first process consists of aligning and ordering the filaments to form a homogenous web, while the second process, which is performed with needles, gives compactness and cohesion to the fibres obtained in the carding process. The result of these processes is felt, a product with specific characteristics of thickness, density and mechanical strength.

Afterwards, the felt is treated with chemical and mechanical processes in order to produce the crude Greige. The name Greige stands for "raw material". This process consists of three main steps. First, the felt product is impregnated with an aqueous solution of polyvinyl alcohol (PVOH). This is necessary for allowing the penetration of TRI into the felt. PVOH also helps to maintain physical properties of the fibres after dissolution of PST. Second, the felt is placed in washing tanks at Blank # 2 °C and circulated with TRI in order to eliminate PST. Then, the product is dried for around 2 minutes at 110-130°C in an oven. The whole process step is kept under reduced pressure through a suction system to avoid TRI workplace exposure. The exhaust ventilation system removes on average 40,000 nominal m³ air per hour, see also ES. Third, the material is impregnated with a polyurethane polymer (PU). PU solidifies and coagulates itself around the PET microfibres. The previously applied PVOH is extracted and the product is dried again in the oven. Afterwards, the mechanical treatment follows: First, the material is splitted in 2 layers, each of them having a half of the original thickness (this process is called “Splitting”). At this stage, a special kind of sanding (called “Buffing”), is performed to remove the layer of coagulated PU and obtain the desired thinness, softness and size of the product.

The last processes are dyeing and finishing, comprising of activities such as cutting in different thickness and colouring of the semi-finished crude according clients requirements.

To sum up, during the second step of Greige processing, TRI is present in a liquid and a gaseous form in the closed system. The recovery of TRI is explained further in detail in the next paragraph. The final product consists of PET and PU and does not contain TRI anymore. For the supply of raw materials, production facilities for PVOH and PU are installed on-site.
2.2.2 TRI recovery

The air, loaded with TRI, is suctioned from the lines involving TRI through vents and, after cooling to Blank # 4 °C, it is led to the centralised abatement facility. All “TRI charged air” (coming not only from the Greige Department, but also from e.g. the pilot plant and other processes) is collected and treated here. This gas treatment facility consists of three main sections: pre-treatment, primary abatement and final post-treatment. In the pre-treatment, the gas evaporating from the TRI-polystyrene solution during the production of greige is treated with two activated carbon pre-filters. They work in parallel and have the function of stopping the high-boiling, partially oily substances (styrene derivatives), which would otherwise decrease the efficiency of the successive primary activated carbon adsorption. Then, the primary abatement follows. It consists of Blank # 5 . Before the carbonaceous material reaches its maximum amount of adsorbable solvent, the activated carbon system is taken out for regeneration with steam in counter current. The mixture of the solvent and the steam, coming out from the adsorber in regeneration, is further led to a condenser. After that, the substances are separated from each other by taking advantage of the insolubility between TRI and water. Purified TRI is led to storage tanks before re-introduction in the process step 2 of the Greige.

Liquid TRI, impure and mixed with PST at Blank # 5 % PST concentration, is recovered through a process that achieves the vital characteristics of pure TRI, which make it suitable for reuse in ALCANTARA’s production cycle. Moreover, this process allows the by-production of PST, so called Alcarene®, for commercialisation purposes. In order to recover the TRI, the impure TRI solution is stabilised with triethylamine and is then pumped into an evaporator. After that, the gas phase is condensed and collected as pure TRI in storage tanks. The resulting concentrated TRI solution with Blank # 6 % of PST coming out of the evaporator is then pumped to the extruder. Triethanolamine (TEA) as a stabiliser is dosed rarely automatically into the pipes directed to the extruder. TEA is
usually used for stabilisation. Stabilisation is necessary to protect condensate lines from possible corrosion at higher temperatures.

The TRI gas, which is evaporated through the initial vent of the extruder, is condensed and collected in a tank with cooled water. To facilitate the elimination of TRI from the PST, the extruder is connected to a vacuum system. The condensate is moved to a tank and is periodically (every three years) sent for purification treatment to an external company. The PST, passing through the vent of the extruder, loses TRI and, at a molten state, is cut into chips. These PST chips then are transported by a water stream, cooled down in a separator and then they are packaged in big bags, commercially known as Alcarene®. Alcarene® are used, for instance, for the production of shoe heels. For classification of Alcarene®, please refer to the ES.

2.3 Volume of TRI in use

The recovery of TRI is important for economical reasons since more than blank #7 tons per year are used at the ALCANTARA site. In contrast to blank #7 tons of TRI necessary for the whole production process, blank #8 TRI were bought in 2013. The difference in usage volume and purchase volume of TRI can be explained by efficient recovery of the majority of used TRI. That is why in 2013 the lowest ratio of 16 g of virgin TRI per produced meter of material was achieved, see Figure 2. The peak in 2012 in Figure 2 is due to cleaning activities made in the TRI storage tanks and the extruder. The sludge in the tanks contained TRI which couldn't be used and thus needed to be replaced by virgin TRI. Moreover, a part of condensed TRI from the extruder cannot be used as a solvent due to the degradation products. Both impure TRI sources are sent out to third parties which distillate TRI. The lack of TRI needs to be replaced by virgin TRI. Such activities are conducted every three years.

![TRI used in g/ produced m of fabric](image.png)

Figure 2: Trend of used TRI for the ALCANTARA process

The needles of the Felt were cleaned with TRI in the past, but this is not done anymore.
2.4 Permit according to IPPC

ALCANTARA Nera Montoro holds an authorisation according to the Integrated Pollution Prevention and Control directive and has received a renewed permit in 2013 following strict requirements for dealing with chemicals, landfills and organic solvents. This permit is valid until 2019.

The IPPC directive and its successor Directive on Industrial Emissions 2010/75/EU (IED) requires industrial and agricultural activities with a high pollution potential to have a permit for conducting their activities (2). In order to receive this permit, however, companies must fulfill certain environmental criteria and this way they bear responsibility for preventing and reducing any pollution that they cause.

Basic obligations with which companies must comply are (2):

- “use all appropriate pollution-prevention measures, namely the best available techniques (which produce the least waste, use less hazardous substances, enable the substances generated to be recovered and recycled, etc.);
- prevent all large-scale pollution;
- prevent, recycle or dispose of waste in the least polluting way possible;
- use energy efficiently;
- ensure accident prevention and damage limitation;
- return sites to their original state when the activity is over.”

Regarding TRI, this means, ALCANTARA has implemented best available technologies for RMM for the use of TRI and thus emissions to the environment are minimized.

2.5 Critical parameters fulfilled by TRI

As shown in the process description, the solvent of choice needs to solubilise PST sufficiently. This process is currently performed at Blank # 9 in the Greige process, see Figure 1. A maximum temperature Blank # 10 for this process has two reasons: First, higher temperatures would result in the formation of more gaseous TRI which would lead to higher workplace concentrations. Second, higher temperatures increase the overall stress on the material which is exposed to mechanical stress in the extraction step as it is lead over rolls. In general, higher temperature causes PET or PVOH degradation. For instance, PET starts to degrade at 70°C. The material changes from elastic to plastic. Furthermore, when it is squeezed in between the rolls, PU will not be able to penetrate and impregnate in subsequent steps anymore. PET is the main component of the fibre, whereas PVOH is needed for structure maintenance during PST extraction by the solvent. PVOH is removed again after solvent extraction.
Besides the temperature condition, compatibility with PET fibres is another prerequisite for an alternative solvent. This means that the solvent must not chemically attack the PET fibres.

The boiling point is closely related to the drying step in Line D, see Figure 1. The drying is conducted for \textbf{Blank #11} minutes and \textbf{Blank #12} °C, whereas the fibre exits the oven at around \textbf{Blank #13} °C. Such short-term exposure to high temperatures does not harm the fibre but allows quick TRI evaporation, despite the fact that at 70°C starts the PET degradation. The \textbf{boiling point} of the potential alternative solvent needs to be between \textbf{Blank #14} °C (boiling point of TRI is 87°C). The higher upper bound of this boiling-point range for a potential alternative solvent is explainable due to the temperature sensitivity of PST this recovery process step should take place at temperatures under 100°C. Moreover, there are machinery constraints. Namely when a higher-temperature-boiling solvent is used, a stronger vacuum becomes necessary (as we need to reduce pressure rather than increase temperature due to the PST temperature sensitivity in order to vaporize the solvent) which is currently not available (another investment in a new machinery would be necessary). Another reason is that the solvent of choice should be recovered by evaporation in order to keep the substance efficiency high. PST chips are gained as a commercial product thanks to the solvent recovery. Besides, there is a tendency to keep energy demands at the lowest levels possible. Nevertheless, higher evaporation temperatures require higher energy input. The value of the lower bound of the boiling-temperature range can be explained by trying to avoid a high volatility of the alternative solvent. Should the potential alternative solvent volatility in the given temperature zone be high, it would result in unacceptable high emissions and workplace exposure concentrations. The ALCANTARA site runs under an IPPC permit which would be affected in case high emissions of a (hazardous) solvent occured.

During the recovery operations where TRI and PST chips are regained (Figure 1) the solvent of choice must \textbf{not degrade} under the set temperatures for the boiling point \textbf{Blank #14} °C. In general, the \textbf{stabilisation of the solvent} should be possible in order to prevent corrosion of pipes/baths.

\textbf{Flammability} of an alternative solvent is an another exclusion criteria because it entails implementation of safety measures like retrofitting of the equipment for explosion-proofness. Such machinery adjustments rise investments significantly in addition to the cost of adjustments necessary for the use of another solvent than TRI. Such additional considerable investments should be avoided.

Another critical parameter defined by ALCANTARA in order to circumvent any avoidable health hazard is a low- or \textbf{non-toxicity} of the alternative potential solvent. Therefore, health and environmental hazards according to the CLP Regulation EC No 1272/2008 (3) were also considered when searching for an alternative.

Based on the explanations made above, the following exclusion criteria were defined:

- PST extraction at \textbf{Blank #10} °C
- Compatibility with PET
- Boiling point
- Not degrade during solvent and PST recovery
- To be able to be stabilized to prevent corrosion of pipes/baths
- Non-flammability
- Lowest toxicity possible

3 ANNUAL TONNAGE

The annual TRI usage tonnage for ALCANTARA's use is 10-100 tonnes per year.

4 IDENTIFICATION OF POSSIBLE ALTERNATIVES

4.1 Description of efforts made to identify possible alternatives

A substances’ list comprising of 37 potential solvent alternatives was provided by ALCANTARA for potential substitution of TRI. The ones out of these 37 substances, which do not solubilise PST, were excluded from further assessment as PST is an essential material in the production of the Alcantara® and thus PST needs to be soluble in the potential solvent. In the second step, solvents that attack PET were not considered further since the solvent must not attack the PET fibers. In case the boiling point of the potential alternative was not in the range of 60-100°C, the potential solvent was deemed as a technically not feasible solution and as such excluded from further assessment. The potential alternative would be either too volatile and would cause undesired emissions and workplace polutions (boiling point under the lower bound) or there would be a need for a currently-not-available stronger vacuum in order to reach the solvent’s boiling point (boiling point above the upper bound). For reasons why the stronger vacuum would be necessary, please see section 1.5 of this document. The implementation of flammable substances was also not desired since not only machinery would need to be changed, but also the whole buildings would need to be amended for explosion-proofness. This would require massive investments and the production process would need to be stopped for a certain period of time for implementation of the required adaptations, which is considered to be economically not feasible. Therefore, flammable substances were also excluded from further assessment.

![Diagram](image)

Figure 3: Exclusion criteria for identification of technically feasible alternatives, in this public version, the specific temperatures in the process steps are not shown

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4.2 List of possible alternatives and exclusions steps

Step 1

The 37 potential alternatives are listed in Table 1. The first exclusion criteria, solubility of PST at temperatures under 40°C was grounded on research in two technical books, namely a polymer handbook (4) and a plastic technology book (5). Substances that did not solubilise PST according to these sources were excluded from further assessment, see first column of Table 1. As it was not clear if the test conditions for examining solubility resemble the process conditions at ALCANTARA, another criteria like flammability needed to be proven non-feasible by the potential alternative to be fully excluded from further assessment.

Step 2

In the second step, the remaining substances were assessed on the basis of PET resistance. Chemical resistance against PET was checked on the basis of two webpages from the association of European Plastic manufacturers (6) and an American distributor of plastic parts (7).

In case of the second source (7), chemical resistance was tested at 73°F (23°C), but no further test conditions like time span of testing were indicated. In case of the association of European Plastic manufacturers (6), chemical resistance was tested under storage conditions at room temperature.

PET resistance was categorised in classes according to good, marginal or low resistance (6) or to no, slight, moderate absorption or complete decomposition of PET (7). Any resistance category lower than to the highest one (good resistance or no absorption, respectively) was classified as "not resistant" in Table 1 since only good resistance ensures PET fibres stay intact.

Step 3

As explained before, the boiling point of the potential alternative needs to be in the range of 60-100 °C. In case the boiling point of the alternative was not in this range, the substance was excluded from further assessment. The boiling point was taken from registration dossiers available on the ECHA website if not indicated otherwise.

Step 4:

If a substance was classified as flammable according to the CLP regulation (3), it was not further assessed. Please see the section 4.1 for the justification.

Step 5:

If only one of the exclusion criteria "not resistant" or "PST not soluble in it" (third and fourth columns of Table 1) were met by a potential alternative, than it was searched for any other exclusion criteria. This is because the test conditions of the sources of both third and fourth criterium from Table 1 might have differed from the ALCANTARA case. In other words, solubility tests designed on basis of the Alcantara process would perhaps show different results (such tests were not conducted). In contrast, the boiling point and flammability presented strict exclusion grounds.
Following this strategy, all substances that did not solubilise PST were excluded due to high boiling point or flammability or both. The same is true for substance that attack PET except chloroform. But the use of chloroform is restricted and shall not be used in diffuse applications like cleaning of materials according to Annex XVII of the REACH Regulation (8). Thus, chloroform cannot be used in ALCANTARA's production and hence, was excluded from further assessment.

Only one substance, namely carbon tetrachloride, met all technical requirements: it solubilise PST, does not attack PET, the boiling point was within the requested range and it was not flammable. Nevertheless, this substance was excluded from further assessment due to the extensive toxic properties to both humans (e.g. carcinogenic) and environment (ozone depleting), see registration dossier of carbon tetrachloride (9). Besides that, carbon tetrachloride is a controlled substance under the Regulation (EC) No 1005/2009 (10) which addresses substances that deplete the ozone layer. The use of controlled substances shall be prohibited according this Regulation. Consequently, carbon tetrachloride cannot be used for the Alcantara production and thus was not further assessed.

Table 1: Substance list and critical technical characteristics upon which potential alternatives were excluded successively. Solubility of PST was gained from a technical book (4). Chemical resistance against PET was evaluated on the basis of two webpages from the association of European Plastic manufacturers (6) and an American distributor of plastic parts (7). The boiling point and flammability was taken from the registration dossiers available at the ECHA homepage (11) or from the webpage chemspider in the case of the not-registered (Dec. 2013) substance Diisopropyl ketone and Iso-hexane (12) (13). n.d. not defined when no information was available on mentioned sources. Health and environmental hazards were taken from either the C&L inventory database from the ECHA website (14) or the registration dossiers of each substance (11).

<table>
<thead>
<tr>
<th>Substance</th>
<th>CAS Number</th>
<th>Solubility Polystyrene (PST)</th>
<th>Resistance Polyethylene Terephthalate PET</th>
<th>Boiling point [°C]</th>
<th>Flammability</th>
<th>Health and Environmental Hazards</th>
<th>Alternative yes or no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>64-17-5</td>
<td>No</td>
<td>resistant</td>
<td>78</td>
<td>flammable</td>
<td>no health or environmental hazards</td>
<td>no</td>
</tr>
<tr>
<td>Iso-hexane</td>
<td>73513-42-5</td>
<td>No</td>
<td>n.d.</td>
<td>~65</td>
<td>flammable</td>
<td>no classification according to CLP regulation available</td>
<td>no</td>
</tr>
<tr>
<td>Pentane</td>
<td>109-66-0</td>
<td>No</td>
<td>n.d.</td>
<td>36</td>
<td>flammable</td>
<td>Health Hazards: Asp. Tox. 2, STOT SE 3, Environmental Hazards: Aq. Chronic 2</td>
<td>no</td>
</tr>
<tr>
<td>Butane</td>
<td>106-97-8</td>
<td>No</td>
<td>resistant</td>
<td>161</td>
<td>flammable</td>
<td>no health or environmental hazards</td>
<td>no</td>
</tr>
<tr>
<td>Substance</td>
<td>CAS Number</td>
<td>Solubility</td>
<td>Resistance</td>
<td>Boiling Point</td>
<td>Flash Point</td>
<td>Health Hazards:</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>---------------</td>
<td>-------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Diethyl ether</td>
<td>60-29-7</td>
<td>No</td>
<td>resistant</td>
<td>35</td>
<td>flammable</td>
<td>Acute Tox. Oral 4, STOT SE 3</td>
<td></td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>100-41-4</td>
<td>soluble</td>
<td>not resistant</td>
<td>136</td>
<td>flammable</td>
<td>Acute Tox. Inhal. 4</td>
<td></td>
</tr>
<tr>
<td>Styrene (Ethylenebenzene, Phenylethene)</td>
<td>100-42-5</td>
<td>n.d.</td>
<td>not resistant</td>
<td>146</td>
<td>flammable</td>
<td>Acute Tox. Inhal. 4, Skin Irrit. 2, Eye Irrit. 2</td>
<td></td>
</tr>
<tr>
<td>THF tetrahydrofuran</td>
<td>109-99-9</td>
<td>soluble</td>
<td>not resistant</td>
<td>55</td>
<td>flammable</td>
<td>Eye Irrit. 2A, STOT SE 3, Carc. 2</td>
<td></td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>141-78-6</td>
<td>soluble</td>
<td>not resistant</td>
<td>77</td>
<td>flammable</td>
<td>Eye Irrit. 2, STOT SE 3</td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td>67-66-3</td>
<td>soluble</td>
<td>not resistant</td>
<td>62</td>
<td>not flammable</td>
<td>Acute Tox. Oral 4, Skin Irrit. 2, Carc. 2, STOT Rep. Exp. 2</td>
<td></td>
</tr>
<tr>
<td>Methylene chloride (Dichloromethane)</td>
<td>75-09-2</td>
<td>soluble</td>
<td>not resistant</td>
<td>40</td>
<td>not flammable</td>
<td>Carc. 2</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>67-64-1</td>
<td>soluble</td>
<td>not resistant</td>
<td>56</td>
<td>flammable</td>
<td>Eye Irrit. 2, STOT SE 3</td>
<td></td>
</tr>
<tr>
<td>Butyl acetate</td>
<td>123-86-4</td>
<td>soluble</td>
<td>not resistant</td>
<td>125 - 127</td>
<td>flammable</td>
<td>STOT SE 3</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>soluble</td>
<td>not resistant</td>
<td>80</td>
<td>flammable</td>
<td>Asp. Tox. 1, Skin Irrit. 2, Eye irrit. 2, Muta. 1B, Carc. 1A, STOT RE 1</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td>soluble</td>
<td>resistant</td>
<td>111</td>
<td>flammable</td>
<td>Acute Tox. Oral 4, Skin Irrit. 2, STOT SE 3, Reprod. 2, STOT RE 2</td>
<td></td>
</tr>
<tr>
<td>Dioxane: e.g. 1,4-Dioxane</td>
<td>123-91-1</td>
<td>soluble</td>
<td>resistant</td>
<td>101 - 102</td>
<td>flammable</td>
<td>Eye Irrit. 2, Carc. 2, STOT SE 3</td>
<td></td>
</tr>
<tr>
<td>Diisopropyl ketone</td>
<td>565-80-0</td>
<td>soluble</td>
<td>n.d.</td>
<td>124</td>
<td>flammable</td>
<td>no classification according to CLP regulation available</td>
<td></td>
</tr>
<tr>
<td>Tetrahydrofurfuryl alcohol</td>
<td>97-99-4</td>
<td>soluble</td>
<td>n.d.</td>
<td>178</td>
<td>flammable</td>
<td>Eye Irrit. 2, Repr. 2</td>
<td></td>
</tr>
<tr>
<td>Substance</td>
<td>CAS No.</td>
<td>Solubility</td>
<td>Resistance</td>
<td>Flammability</td>
<td>Health Hazards</td>
<td>Hazard Class</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>------------</td>
<td>------------</td>
<td>--------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Xylene</td>
<td>1330-20-7</td>
<td>soluble</td>
<td>resistant</td>
<td>flammable</td>
<td>Health Hazards: Acute Tox. Oral 4, Acute Tox. Derm. 4, Skin Irrit. 2</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Cyclohexanone</td>
<td>108-94-1</td>
<td>soluble</td>
<td>resistant</td>
<td>flammable</td>
<td>Health Hazards: Acute Tox. Inhal. 4</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Methylcyclo-Hexane</td>
<td>108-87-2</td>
<td>soluble</td>
<td>n.d.</td>
<td>flammable</td>
<td>Health Hazards: Asp. Tox. 1, Skin Irrit. 2, STOT SE 3, Environmental Hazards: Aquatic Chronic 2</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>75-15-0</td>
<td>soluble</td>
<td>resistant</td>
<td>flammable</td>
<td>Health Hazards: Skin Irrit. 2, Eye Irrit. 2, Repr. 2, STOT RE 1</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>N-butyl phthalate</td>
<td>84-74-2</td>
<td>soluble</td>
<td>resistant</td>
<td>not flammable</td>
<td>Health Hazards: Repr. 1B, Environmental Hazards: Aquatic Acute 1</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Methyl phthalate</td>
<td>131-11-3</td>
<td>soluble</td>
<td>n.d.</td>
<td>not flammable</td>
<td></td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Ethyl phthalate</td>
<td>84-66-2</td>
<td>soluble</td>
<td>n.d.</td>
<td>not flammable</td>
<td></td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Dimethyl-formamide</td>
<td>68-12-2</td>
<td>soluble</td>
<td>n.d.</td>
<td>not flammable</td>
<td>Health Hazards: Acute Tox. Inhal. 4, Eye irrit. 2, Acute Tox. Derm. 4, Repr. 1B</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Tributyl phosphate</td>
<td>126-73-8</td>
<td>soluble</td>
<td>n.d.</td>
<td>not flammable</td>
<td>Health Hazards: Acute Tox. Oral</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Substance</td>
<td>CAS Number</td>
<td>Solubility</td>
<td>Resistant</td>
<td>pH Value</td>
<td>Flammability</td>
<td>Health Hazards</td>
<td>Classification</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------------</td>
<td>------------</td>
<td>-----------</td>
<td>----------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Tetrachloroethylene (Perchloroethylene)</td>
<td>127-18-4</td>
<td>n.d.</td>
<td>resistant</td>
<td>121</td>
<td>not flammable</td>
<td>Health Hazards: Skin Irrit. 2, Skin sensit. 1B, STOT SE 3, Carc.2</td>
<td>no</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>79-34-5</td>
<td>n.d.</td>
<td>n.d.</td>
<td>121</td>
<td>not flammable</td>
<td>Health Hazards: Acute Tox. Derm. 1, Acute Tox. Inhal. 2, Environmental Hazards: Aquatic Chronic 2</td>
<td>no</td>
</tr>
<tr>
<td>1,1,1,2-Tetrachloroethane</td>
<td>630-20-6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>no classification according to CLP regulation available</td>
<td>no</td>
</tr>
<tr>
<td>Cyclohexane</td>
<td>110-82-7</td>
<td>soluble</td>
<td>n.d.</td>
<td>81</td>
<td>flammable</td>
<td>Health Hazards: Skin Irrit. 2, Asp. Tox. 1, STOT SE 3, Environmental Hazards: Aquatic Acute 1, Aquatic Chronic 1</td>
<td>no</td>
</tr>
<tr>
<td>Methyl ethyl ketone (MEK, Butanone)</td>
<td>78-93-3</td>
<td>soluble</td>
<td>resistant</td>
<td>80</td>
<td>flammable</td>
<td>Health Hazards: Eye Irrit. 2, STOT Single Exp. 3</td>
<td>no</td>
</tr>
</tbody>
</table>

In view of above made explanations no substance listed in Table 1 is technically feasible. A further search of other possible alternatives like non-flammable blends that have a suitable boiling point was not conducted because ALCANTARA envisages to implement a totally new process: the FANS process. ALCANTARA holds patents on this process: Italian patent MI2012A001780, international patent WO2014/087271 and European patent EP13821945. Suitability and availability of this process is described in the following chapter.
5 SUITABILITY AND AVAILABILITY OF POSSIBLE ALTERNATIVES

5.1 FANS (Future ALCANTARA Non Solvent) Project

ALCANTARA's FANS project foresees the complete elimination of TRI and Dimethylformamide (DMF) from the production process by exchange of one of the raw materials. No organic solvents will be used anymore in the FANS process. The FANS process is a technically feasible alternative to the existing process with TRI. The implementation of the FANS process will be done in parallel to the current production until it can fully substitute the conventional production.

5.1.1 Description of FANS technique

5.1.1.1 Characteristics of the FANS process

DMF is also a SVHC (toxic to reproduction) as TRI and was prioritised in 2013 to be included in Annex XIV. Against this background, it needs to be emphasised that the FANS process replaces both TRI and DMF, although the present AoA as part of the application for authorisation only covers the use of TRI. The envisaged replacement of substances and the entailed modification of machinery are sketched in Figure 4.

The FANS process envisages suppressing the use of both solvents by changing one of the raw materials, PST, by an anionic co-polyester named Alkali Soluble polyester (ASP). The main advantage of ASP is that it does not require using TRI solvent, because it will be removed with a hot aqueous solution of an alkalic substance (NaOH) in the second production stage of the Greige process. Therefore, TRI, currently used for the removal of PST at the Felt production stage will no longer be required due to the presence of the new raw material ASP. Furthermore, DMF, used for synthesizing polyurethane (PU), will be substituted by employing a polyurethane solution in water (PUR) instead. At the beginning of the implementation of the FANS process, PUR will be bought from outside, but in future the existing PU synthesizing plant will be modified for the production of PUR.
5.1.1.2 Substance ID and properties of used substances

Regarding the substitution of TRI, both the ASP and the aqueous solution of the alkalic substance, NaOH, are the alternative substances that make an abatement of the use of TRI possible.

Table 2: Substances' names and identification numbers of TRI and NaOH were taken from registration dossiers of the dissemination website of ECHA (15) (16). The main substance of ASP is polyethylene terephthalate which was only pre-registered when checked in December 2013.

<table>
<thead>
<tr>
<th>Substance</th>
<th>EC number</th>
<th>EC Name</th>
<th>CAS number</th>
<th>IUPAC name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichloroethylene</td>
<td>201-167-4</td>
<td>trichloroethylene</td>
<td>79-01-6</td>
<td>1,1,2-trichloroethene</td>
</tr>
<tr>
<td>ASP, pre-registered main</td>
<td>607-507-1</td>
<td>-</td>
<td>25038-59-9</td>
<td>-</td>
</tr>
<tr>
<td>substance is polyethylene terephthalate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NaOH</td>
<td>215-185-5</td>
<td>sodium hydroxide</td>
<td>1310-73-2</td>
<td>sodium hydroxide</td>
</tr>
</tbody>
</table>

As both substances, ASP and NaOH, are not substitutes on its own for TRI, but the whole FANS process is, physico-chemical characteristics of neither ASP nor NaOH are displayed here as they cannot be taken as reference for their technical suitability. Their properties will be discussed further down below. Instead, the whole process is discussed whether it is technically feasible.
5.1.2 Reduction of overall risk due to transition to the alternative

NaOH is a non-flammable substance which is classified as a skin corrosive according to the C&L inventory database, see Table 3. ASP as a whole as well as its main component was not classified when this document was written in December 2013.

Table 3: Self-classification of the registrant DOW of TRI. Classification (GHS) of ASP and NaOH according to regulation EC No 1272/2008 from ECHA dissemination webpage (17). P-statements were derived from the H-statements on the basis of the regulation EC No 1272/2008 (3)

<table>
<thead>
<tr>
<th>Labeling and Hazard Pictogram</th>
<th>Hazard Classes</th>
<th>H statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichloroethylene</td>
<td>Danger, Exclamation mark, Health hazard</td>
<td>Health Hazard: Skin corrosion/irrit. 2, Skin sensitization 1B, Serious eye damage/Eye irrit. 2, Carc. 1B, Germ cell mutagenicity 2, STOT SE 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Hazard: Aquatic Chronic 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Labeling and Hazard Pictogram</th>
<th>Hazard Classes</th>
<th>H statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASP</td>
<td>Not classified</td>
<td></td>
</tr>
</tbody>
</table>
risk for the environment resulting from the very low TRI emissions occurring at ALCANTARA. Other environmental impacts like water quality or green house gases are difficult to predict since differences in energy and water consumption were not assessed yet. Against the background that the risk to the environment for TRI use as well as for FANS are considered to be negligible, no detailed assessment has been performed. It can be assumed that implementation of FANS results in a reduction of the overall risk.

5.1.3 Availability

ALCNTARA developed a project plan for Italian authorities for implementation of the FANS process, see Table 4. The full implementation of the FANS process and full replacement of the current process with TRI is planned for 2024 assuming a best-case situation. However, it is assumed that already in 2016, 14 % of Alcantara® will be produced with the FANS technology, see chapter 5.1.3.2.3. Investment costs related to the implementation of the FANS technology are displayed in the chapter of economic feasibility 5.1.4.

NaOH was registered for 10 - 100 Mio tonnes per year (16) and thus is available on the market in sufficient volume. ASP is also available in sufficient volumes according to ALCANTARA investigations. The whole process is not readily available after the sunset date of TRI in 2016, whereas machinery adaptations are conducted in parallel to customer qualification. Moreover, machinery adaptations is only continued if the steps of customer qualifications are passed successfully.

The FANS process is currently in its pilot stage whereas its implementation entails several new installations and retrofitting efforts. The retrofitting of the current production lines affect the Fibre, the Felt and the Greige process. The relationship between machinery adaptations and production output, existing and planned lines are explained in the first part of this chapter. Customer qualification for all products required by these new installations is an another constraint which is explained in the second part of this chapter.

5.1.3.1 Technical FANS project plan

5.1.3.1.1 Prototype production

Figure 5 displays the number of running production lines and which lines are adapted or built newly for the FANS process. Table 4 shows the foreseen timeline of each implementation step of the FANS process.

For first testing of the new material within customer qualification prototype samples are produced in one of the Fibre lines and subsequently in one of the Felt lines. This is possible as the existing production lines of the Fibre and the Felt step can be used with the FANS process with minor modifications. All Felt lines are called FOSP. This is where cardening and needling takes place.
In order to ensure delivery of Alcantara® produced by the conventional process using TRI which is approved by the clients, after batch production of FANS fibre all production lines have been turned back to be used for normal fibre.

Afterwards, the Greige production step follows with a time lag. Greige prototype samples are produced until November 2014.

5.1.3.1.2 **Industrial scale production**

For the implementation of the whole process on industrial scale, a 2-step modification is conducted as follows.

**FANS Implementation 1**
As TRI will be not be used anymore, the recovery system for it will either be used for other substances or simply be sold. The same actions are expected for the emission abatement system for TRI. The water that is generated by the dissolution of ASP in NaOH will be sent to the water
treatment system. No adaptation of this system is currently expected. Table 4 shows the foreseen timeline for the implementation of each of the steps.

Table 4: Timeline for implementation of the FANS process

<table>
<thead>
<tr>
<th>Blank #24</th>
</tr>
</thead>
</table>

The FANS process can replace the current process with TRI to 100% approximately in the year 2024 in a best-case scenario. This means, if customer qualification goes according to the project plan TRI will not be used anymore in the ALCANTARA production site in the year 2024.
5.1.3.2 Customer qualification timeline

5.1.3.2.1 Who demands product qualification?

Customer qualification is required for 86% of the total production output. This means whenever a change in product from client's or ALCANTARA's site is planned, the new product must run through a clients’ qualification phase. Aim of this procedure is to make sure that the new product meets all quality characteristics requested by the clients as well as the schedule production timeline and the production volume.

Depending on the sector, all or just a percentage of the clients demand such a qualification, see Table 5. All clients of the automotive industry that represents the biggest share of overall sales, for instance, require customer qualification, whereas the shoe industry does not demand a qualification program. Especially manufacturers of premium cars would not accept unqualified Alcantara® because otherwise they would risk their brand name which stands for the highest quality standards.

Table 5: Overview of sectors that need customer qualification

<table>
<thead>
<tr>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Goods</td>
</tr>
<tr>
<td>Automotive</td>
</tr>
<tr>
<td>Industrial</td>
</tr>
<tr>
<td>Shoes</td>
</tr>
<tr>
<td>Interior (Aviation, Contract, Marine)</td>
</tr>
<tr>
<td>Accessories</td>
</tr>
<tr>
<td>Fashion</td>
</tr>
</tbody>
</table>

5.1.3.2.2 Exemplary timeline for qualification of one product

In the following, the customer qualification of a previous Alcantara® material for a premium car manufacturer done in the past is described in order to highlight necessary steps for the automotive sector.

1. Input phase by customer (car constructor):

Starting in November 2004:

- The premium car manufacturer requested a new Alcantara® product for seat application. This new product was requested to have higher mechanical resistance and increased colour resistance against UV-light. A schedule of business was worked out. ALCANTARA’s technical marketing department opened a new project.

The input phase takes between 3 and 6 months on average.

2. Project phase (ALCANTARA and car constructor)

Starting in February 2005:

- The marketing department and the customer innovation department released a development plan to the car manufacturer.
• Sample material was produced and prototype testing in the laboratory started by the car constructor and ALCANTARA.

• Besides laboratory tests, field tests are requested by clients when substantial changes of the Alcantara® material properties is foreseen. For the automotive industry, field tests are conducted in very cold and very hot climate conditions. Thus, the pieces of the new Alcantara® product are exposed to direct sunlight in the Arizona or the Kalahari desert for 3 to 4 months and to minus degrees in Northern Europe regions. Changes in material, e.g. color changes, are examined afterwards. In case tests are not successful, the client goes back to ALCANTARA which amends production and tests are run again with slightly changed FANS materials. At the end of successful field tests, industrial scale production of each product can start.

Field tests can prolong the project phase from 6 months up to 2 years.

3. Homologation phase

September 2005:

• ALCANTARA’s marketing department communicated that the car manufacturer approved the proposed product. Codification of the product started. This means, the production route was defined and got a number for identification.

December 2005:

• ALCANTARA and premium car manufacturer released the final product control plan and set the technical purchase specifications. Costs and logistic conditions were defined.

• In general, production phase can start several months after the end of homologation phase depending on the client’s request. That way, time delays in industrial scale production can appear because e.g. cars cannot be readily equipped with the new FANS material.

So, the minimal time for homologation is half a year.

4. Production phase

January 2006:

Production of the new Alcantara® product started.

Time needed in total for customer qualification of one product in automotive industry

To sum up, all steps until production take between 1.5 - 3 years for a one new Alcantara® product.

5.1.3.2.3 Timeline for qualification of whole portfolio of ALCANTARA

ALCANTARA has more than 50 (the exact number can be found in confidential version, Blank #27) different Greige intermediates or also called "bases". Out of these bases, a number in the range of 2000-5000 of customized products (the exact number can be found in confidential version, Blank #28) are formed depending on client's requirements like mechanical properties but also color differences. So the production steps, dyeing and finishing (see Figure 1), are different for each of
these products. Each product has its own code of production, that identifies production steps that lead to these certain characteristics of the product. Most codes exist for Automotive as individual industry sector, see Table 6. Both the bases and the customized products need to be approved by the clients.

Table 6: Number of codes per industry sectors

<table>
<thead>
<tr>
<th>Industry Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior, Naval, Aviation, Outdoor</td>
</tr>
<tr>
<td>Automotive</td>
</tr>
<tr>
<td>Fashion</td>
</tr>
<tr>
<td>Unbranded</td>
</tr>
<tr>
<td>Industrial</td>
</tr>
<tr>
<td>Electronic goods</td>
</tr>
<tr>
<td>Strollers and child’s seats</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

In general, an increase of total production is planned until the year 2024 when the FANS process will have fully replaced the conventional production process with TRI (Figure 6).

As shoe industry does not require customer qualification processes, this industry sector is supplied first by FANS fibers in 2014 with small amounts. From 2017 onwards, the shoe industry will exclusively be delivered by FANS fibers.

In 2015, 2016 and 2017 further clients that also do not require customer qualification will be served next: parts of fashion and parts of interior. Additionally, those products with short customer qualification phase and little production volumes are manufactured with FANS process: Industrial goods, accessories and parts of electronic goods. In some cases, customer qualification will have finished early in the timeline, so the sector is fully supplied by FANS fibers, e.g. industrial products will be manufactured to 100% by the FANS process in 2018 whereas this happens in 2021 for accessories. Due to increase of products for each sector, production volumes for each sectors increase also.

In 2017, some products for automotive industry will have passed client's approval depending on how high the efforts for customer qualification are. Relevant matter for automotive sector is that if a qualified product is used on a car model, ALCANTARA must ensure its supplying for a certain time, e.g. until this car is not produced anymore. A constructor doesn't plan or budget requalification costs for a new product for this time. This is one reason why qualification process for the FANS products for automotive industry start partially later than for other clients and additionally can be more time intensive, e.g. field tests are demanded.

Moreover, due to the capacity constraints, qualification process cannot start in 2014 for all clients as production lines running with FANS are implemented stepwise as explained before. Furthermore, staff to coordinate every single customer qualification for a number in the range of 2000-5000 (the exact number can be found in confidential version, Blank #28) customized products is not readily available in 2014. Therefore, all qualification projects are spread in a wider time span.
As stated before, it is assumed that the customer qualification for the whole product range of ALCANTARA will be accomplished by 2024. To fill in the gap before FANS can fully replace the conventional production route, the solvent-type Alcantara® (with TRI) needs to be produced until approximately 2024, but only in small amounts at the end.

![](image)

**Figure 6: Foreseen production volume of FANS process divided by industry sectors**

5.1.4 Economic feasibility

Economic impacts on suppliers and clients of ALCANTARA are limited to TRI-suppliers and producers when TRI is less/not ordered anymore by ALCANTARA during FANS implementation. Suppliers of other raw materials than TRI, post-treatment service providers and downstream users would remain more or less the same (except suppliers for new raw materials for FANS process) when FANS fibres are produced. Therefore, economic feasibility is discussed on basis of ALCANTARA itself only.

In the SEA, it was described in the non-use scenario that a stop of TRI-based Alcantara® and a production only based on the FANS process in 2016, would result in income losses for ALCANTARA until 2021 since FANS cannot cover for full capacity production in 2016. A break even would be reached in 2022. This means, economic feasibility would be reached by then. In 2024, FANS would be fully implemented, 100% of the production output would be based on FANS fibre. Obstacles and difficulties for FANS implementation was given in chapter 5.1.3.

The FANS project involves a considerable investment for remodeling of the production facilities which are listed in the following.
Table 7: Necessary investments for implementation of the FANS process

It is planned that this volume is expanded with the FANS process once it is fully implemented, see chapter 5.1.3. Quality of the endproduct, Alcantara®, and the price of it is expected to stay stable when produced with the FANS process. ALCANTARA's Japanese owners already expressed their agreement with the foreseen investments.

5.1.5 Conclusion on suitability and availability for the FANS process

The FANS process is a technical and economical feasible alternative process to the current process with TRI. The substances used in the FANS process are beneficial for human health and environment due to its favourable classification profile, e.g. no carcinogenic substance will be involved anymore. The full implementation of the FANS process and thus 100% replacement of TRI is expected for 2024.
Table 8: Conclusion about suitability of the FANS process

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Fulfilled by FANS process</th>
<th>Activities required to make the FANS process a suitable alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical feasibility</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>Economic feasibility</td>
<td>Yes</td>
<td>In case investments can be split to several years until 2024. As shown in the SEA, splitting the investments to less years (e.g. until 2020) is impossible.</td>
</tr>
<tr>
<td>Reduction of risk</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>Availability</td>
<td>No</td>
<td>The process will replace the current process using TRI to 100% in approximately 2024.</td>
</tr>
</tbody>
</table>
6 OVERALL CONCLUSIONS ON SUITABILITY AND AVAILABILITY OF POSSIBLE ALTERNATIVES

37 solvents were evaluated for their technical feasibility to replace TRI in the production process of Alcantara®, an [Blank #1] composed material. On basis of physico-chemical properties, each potential alternative solvent was examined if it fulfils four main technical criteria: ability to solubiilise PST at temperatures below 40°C, good resistance of PET when coming in contact with the solvent, having a boiling point between 60-100°C and solvent’s non-flammability. These technical criteria were derived from the current production process. In case the solvent failed to fulfil any of the required criteria, it was not further discussed and discarded from the list. Substances remaining on the list were excluded on the basis of regulations that ban their use. Result of this evaluation was that none of the 37 solvents was technically feasible or available. Laboratory testing of alternative solvents was omitted at ALCANTARA due to the intent to implement an alternative production process: Instead of replacing TRI by another solvent, the applicant plans to omit the use of any hazardous solvent and instead modify the whole process. This so called "Future ALCANTARA Non Solvent" Project (FANS) foresees abandoning the usage of TRI and DMF, another SVHC, by changing one of the raw materials. A project plan with defined time-frame was developed by the applicant New machinery and necessary retrofitting of existing production lines will be implemented in parallel to the existing process. The production output from the FANS process will replace step by step the production output from the conventional process. Besides necessary technical modifications, customer qualification is demanded. This approval process prolongs the time line beyond the time necessary for the technical adaptations. It is expected that the FANS process will have replaced the current process to 100% in 2024.
7 APPENDIXES

7.1 Abbreviations

DMF Dimethylformamide
FANS Future ALCANTARA non-solvent
IPPC Integrated pollution prevention and control directive
PET Polyethylene terephthalate
PST Polystyrene
PVOH Polyvinyl alcohol
PU Polyurethane polymer
PUR Polyurethane solution in water
TRI Trichloroethylene
ASP Alkali soluble polyester
NaOH Sodium hydroxide

8 REFERENCES


