

## CASE STUDY REPORT

Company Name: Appia

Company Address: 8 rue de Dauphine, BP 357, 69960 CORBAS, Lyon, FRANCE

Company contact: Jerome Marcilloux (jmarcilloux@appia.fr)

Website: www.appia.fr

Title: Vegetable oil as a bitumen solvent in road construction

Crop: Sunflower (*helianthus annuus*)

Family Group: Oils

Stage: Pilot-Scale

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### SUMMARY

A large, private, French company with its headquarters in Paris and a main laboratory just outside Lyon. They have a long history in the supply of various road construction materials. It has developed a bitumen solvent based on vegetable oil in place of mineral oil. The drivers for change are improved health & safety for workers and the public; improved environmental impact due to lowered VOCs and the prospect of long-term price stability, independent of crude oil prices.

These vegetable oil-based fluxants now represent 15 per cent of all fluxants used by Appia to make roads. Appia have secured a PCT patent on the application of their new oil-based technology to road building.

Although the French market is limited to 30,000tpa, the application is global so Worldwide license income could be generated in the future from this European idea.

There is an environmental incentive for everyone to promote this system because the full benefits are not felt unless everyone transfers to this system. Having only one company in one country reducing VOCs does not impact greatly on global pollution.

I have translated a chapter from a booklet by ADEME (attached) which is a good example of trying to get the message over to the public of how relevant to everyday life RRM's can be.

The project seems a good example of a large company using private in-house research resources to take a locally grown crop (sunflower) and create a new application. This application could have global benefits to the environment wherever roads and paths are made using bitumen technology.

### BACKGROUND TO THE COMPANY

Appia began in 1928 by specialising in the development and marketing of bitumen binding agents used in road construction. It is a 100% subsidiary of the huge Eiffage Group. This construction conglomerate has a 6.7 Bn € turnover built on three sectors being 30 per cent road construction; 45 per cent (general) construction and 25 per cent electrical/energy projects.

It owns and/or has interest in three separate companies with road construction interests: SCR; Beugnet and Garland each with strong 'local names' in particular regions. In 1999, the road interests of all three were grouped under Appia to form a major European road construction player. In 2000, Appia generated a turnover of Bn €1.6 and employed 11,700 people. In 2001, it had 15,000 employees and sold 200,000t of bitumen emulsion, its main product.

Appia is now present in all areas of road construction:

- large motorway projects;
- arterial road construction & maintenance;
- energy and telecoms networks;
- production of binding agents and aggregate mixes;
- exploitation of quarries for aggregates

Appia is the key company in this project. It is a result of regrouping three companies, each with a long-established name. Garland, for instance, is strongly known in the Lyon area.

Appia directors anticipated the trend in environmental practices and legislation took positive steps to initiate a programme of R&D within the company to find a safe alternative. Appia is large enough to sustain its own extensive laboratories and highly skilled staff. Most are engaged on regular quality control matters relating to day to day production but an ongoing program of R&D is always maintained. In 1996, the Director of Research at Appia began on an in-house R&D project with no external funding, to find a 'safe' alternative to solvents currently used as the fluxant in bitumen-based road-surface coatings. The word 'safe' had two meanings in this context – but both relate to the same phenomena:

(1) Hydrocarbon-based binders have a flash point around 160°C. and function by evaporation of the volatile fraction when heated on-site, after coating the mix in a factory. In the factory the mixture is

taken to beyond the flux flash point during the process, to ensure thorough coating & mixing of the many components. This is a dangerous stage as the mixture is explosive, and industrial accidents have occurred. One such occurred at Appia and is in part the reason for initiating the current project. Fortunately no one was killed in the incident.

(2) During applications of the top dressing on-site workers are exposed to high levels of Volatile Organic Compounds (VOC's). These fumes impair their ability to visually inspect quality (they must not get too close to the hot gases emitted for Health and Safety reasons). Even passing motorists have been recorded to have suffered drowsiness & headaches from the fumes.

## SUPPLY CHAIN

Sunflowers have always traditionally been grown in the South of France. Breeding of new varieties for more Northern latitudes however has extended the practical growing limit more Northwards each year. According to the IENICA country report for France, prepared by ADEME in 2000, in 1997, 895,000 hectares were planted giving an average yield of 2.3 tonnes per hectare and a total harvest amount of around 200,000 tonnes of seed. At 40% extraction this would give 80,000 t of raw oil, nationally per year..

Since 1987 the area has been stable above 800,000 ha minimum each year, with yields never below 1.5t per ha (some years as high as 2.7t per ha)

Appia has entered into a cooperation agreement with Diester Industries. This company crushes the sunflower seed and chemically modify it by esterification. Diester Industries also have interests in bio-gasoline (bio-diesel).

In France the sunflower sector is represented by:

Onidol (Organisation Interprofessionale des Oleagineux) – 12, Avenue George V  
75008 Paris

Tel: 0140694800

Contact: Claude Sylvain

For Appia one of the keys was identifying and cooperating with Diester Industries. The cooperation with Diester Industries to create 'Oleoroute' as a supply stabilisation mechanism means Appia can budget on a fixed price for SFO for up to five years. This could never be done with mineral oil due to high market fluctuations. However this also stresses the need for a confident framework for farmers to be able to plan and commit to such agreement in the long term. (Note Diester industries has same address and contact as Onidol above).

Bitumen is a by-product of the refining of crude mineral oil. In its natural state it is highly viscous. To make it workable for road construction a Fluxing agent or solvent is applied as well as other ingredients to give the desired performance; sand, stones and elastomer polymers.

The solvent is specifically created to act as a 'fluxant' for use with bitumen in road surfacing mix. Conventionally, a petroleum-based solvent is used together with heat, to keep the mix of pure bitumen and stones (aggregates) as a workable, viscous material. During the final application stage on-site, the mix is taken up to higher temperatures - beyond the flash-point of the solvent. The mix is laid and compacted and the solvent is thus driven off by evaporation leaving a solidified layer ready for road-traffic. However, noxious fumes containing Volatile Organic Compounds (VOC's) are given-off by the process and these damaging to the atmospheres and are injurious to workers and can even affect passers by. It is also an intrinsically unsafe process due to the fire risk posed by the volatility of the petroleum -based chemicals being used on-site near naked flames (bottled-gas-fired, bitumen heaters). Appia have been developing this alternative since 1996 and it is now in the early stages of commercialisation.

Conventionally the mineral-oil-based solvents are heated to above their flash point to evaporate them off. The fluxant therefore has only a transient role while the mix is worked and levelled into position. However, this produces fumes, which, by reducing visibility on site at the line of application, can affect the quality of work because workers cannot see clearly, and safely, what is going on in the 'hot' area. The aim of the project was to produce a new generation of hot-spread binders to overcome these disadvantages without a negative effect on road performance.

## MARKET & MARKETING ISSUES

The French market scenario for bitumen is very peculiar, and for Appia is unique to France. In other countries different marketing strategies would apply. In France there are only 3 major companies bidding for major projects. Appia is the smallest.

Road surfacing is the direct responsibility of the local French 'Department' – or administration. They

also have their own in-house workforce and equipment to process building materials as an alternative to the private contractors.

So Appia can find itself as either a main contractor, where it supplies its own materials to its own construction crew; or simply as a supplier of raw materials to the public administration work force. Currently Appia produce 3,000t of vegetable-oil-based fluxant per year. This is sufficient to gain substantial data, both financial and technical on its production cost and performance. The total French market for surface dressing is estimated at 30,000t. However for a variety of reasons, the real ceiling is likely to be 20,000t for vegetable-oil based substitute. Currently, the cost of production is six to ten per cent more with the vegetable oil-based product. This is largely due to the higher cost of the new oil.

## FUTURE DEVELOPMENT

Currently a Technical Development Program is underway with the Bordeaux Technical Institute involving R&D to improve the performance of BIOFLUX & BIOFLEX to broaden the area of application. The two year program is now in its second year and results are encouraging (and hence confidential!). Expansion with other countries may seem a logical next step. Particularly other European countries with high environmental concerns such as Germany or Sweden.

Appia do have small subsidiaries and associated companies in Spain, Belgium, Portugal and Germany but these are not suitably scaled to tender for large contracts.

Each country has its particular systems of administration of road-construction projects so it is most likely that Appia would operate by licensing the technology to an acceptable local partner company in each country. This is where the patent registered in September 1997 will extend the use of the technology while retaining control by Appia of its progression.

Another market sector is that of 'storable asphalt'. This uses high levels of Fluxant to maintain workability over a long period. It is important in road-repair rather than new construction. The sunflower oil fluxant is showing promising results in this sector.

A further factor is that the high cost of production is partly due to using existing factories. These are designed to a high (expensive) specification because of the fire & explosion risk from petro-carbon fluxant. Any planned, dedicated vegetable-oil based factory could be built to a lower specification and therefore be cheaper to build and run in the long-term. This factor has yet to be included as there is insufficient volume to justify it.

Under pressure from World, National and regional concerns for environmental impact, French 'Departments' are having to adopt policies for Sustainable Development.

At the moment the one to ten per cent higher price is hard for the customers (Department) to justify. However, given more hard data on environmental impact of emissions from road building it may be possible to quantify the benefit from adopting veg-based products such that the premium can be justified financially.

The modified sunflower oil is traded at around €720 per tonne while the hydrocarbon equivalent, petroleum fluxant, is only €320 per tonne

Appia have calculated that 1 ha of sunflower crop will supply sufficient fluxant when processed to surface 1 ha of road (No of km of road depends on road width).

They have recorded over 10 million m<sup>2</sup> of road surface completed using sunflower oil-based fluxants since the first trials in 1997.

The products are sold under the registered trade names BIOFLUX and BIOFLEX.

## CONCLUSIONS

This product has been the result of forward thinking management developing a long-term strategy. They are large enough to have the resources to follow this through despite short term set-backs such as mineraloil prices being lower than predicted, making the new binder relatively more expensive. As a product the binder has a significant role to play in helping to reduce aerial pollution with VOC's. The benefits to the company and the full benefits to society will not be felt until all road construction and repair is converted over to this system.

The product will use a significant portion of the annual, national crop, but the total area needed can be easily handled by extending the growing range slightly.

## STRENGTHS

- Health and Safety issues for workers on-site, passers by and factory workers
- Significant reduction in VOC's improve environment
- Source raw material (sunflower oil) is sustainable within local region

- More economic when new, lower cost factories come on-stream
- Road-surface quality improved - workers can see road-formation more clearly

#### WEAKNESSES

- Higher price currently due to relative prices of raw oils
- Price/supply volatility depending on other demands for sunflower oil
- Product cannot yet be used in very heavy traffic roads
- Application only April-September due to need for no rain and 10°C road temp
- Competition may be ready to introduce own brand similar products

#### OPPORTUNITIES

- This work has led to potential other new products
- Possibilities to expand into other countries with same product
- Possibilities of developing a range of products based on other oils
- Expansion may come due to effects of pending environmental legislation

#### THREATS

- If mineral oil prices remain low or drop even lower due to global events and political pressure, sunflower oil product could become uncompetitive
- If costs of farming sunflowers rises for any reason, raw vegetable oil price will increase (unless subsidised), makes the product uncompetitive
- Other similar companies are known to be developing their own formulations to get around the APPIA patent