engINdia & EWB-UK Research

Project Proposal: Oil Mill Optimisation

Full description of Problem:

Peanut (or ground nut) oil is used as a cooking oil to cook many foods in India, particularly in Maharastra. In the rural village of Pabal, Maharastra, the traditional process to obtain peanut oil was by the use of a grinding machine (resembling a scaled-up pestle and mortar), powered by a single bull. The peanut seeds were placed into the machine via the top of the bowl and then the wood grinder was pushed in to position. The grinder was then rotated by the bull's walking around the grinder (as shown below). The oil was collected from a side-collecting outlet. The shells and residue (called the oil 'cake') was then collected from the bottom of the bowl and used as cattle feed. This process is still used today in some parts of Maharastra.

Photograph showing the traditional Oil Milling Process.

In Pabal, a peanut oil mill (called "Pabal Oil & Dal Mills") was established 40 years ago. As a result the traditional method of obtaining oil stopped and the grinding machines were discarded on the street.

The peanut oil mill takes dried peanuts, shells them and crushes them to obtain the oil. The detailed process is given below.

How the local community will use the proposed solution:

The oil mill employs 45 people directly in Pabal and perhaps many more indirectly (transportation etc.); in fact a hostel is provided for the workers to stay in. The optimisation of the oil mill would increase the profit that the oil mill would collect and hence increase property in the area. The oil mill could as a result grow and process other oils full time, providing more jobs in Pabal and increasing the money coming into Pabal. The owner is also a leading member of the Jain community, which has been very generous in developing Pabal as a whole. Therefore increasing his wealth would help everyone in the local community.

Estimate of the economic benefit anticipated and plans for training of the local community:

There is a large scope for economic benefit for the oil mill, which the owner freely admits to be inefficient. The economic benefit that can be anticipated can easily be twice his present profit margin, if not more.

The staff employed in the mill is a semi-skilled workforce that can operate and maintain the process of peanut oil milling. If new materials or operations were implemented they would not have trouble re-adjusting to the new methods. Their skills would stop at the information and communication technologies level, as it would have to take significant training to make the current workforce proficient with computers.

The project would impact the community by increasing the amount of money coming into Pabal and attracting industrial improvement in general to the area. If an excellent, generic design for an optimisation can be made then the design can be passed on to other seed oil producers in India and other parts of the world, thereby decreasing waste and decreasing the amount of energy unnecessarily wasted.

Full description of the local situation:

The mill has a capacity of producing 7-8 tonnes of peanut oil per day. However, due to power cuts, usually only 4 tonnes are produced. Since the process takes an hour to reach full productivity, power cuts are a massive problem for the running of the plant, so an optimised solution should take these power cuts in to account. The details of power cuts are given in the engINdia Final Report.

The supply of peanuts is seasonal. Productivity reaches a maximum during the monsoon season (May - September) and the Indian summer (January - March), where the mill can process 250 sacks of peanuts (weighing 40 kg each) per day (with the power cuts). The peanuts can be stored for up to 6 months before spoiling. The peanut supply reaches zero for the two months when peanuts are not in season.

The mill conducts the following process:

1. A bucket-elevator raises the peanuts from the bag storage to the initial sieve.
2. The sieve removes the general dust present.
3. The nuts are passed into the sheller. The sheller breaks the shells and the seeds are removed.
4. The seeds and shells are elevated so that they can be passed into the destoner.
5. The seeds and shells are passed to the destoner, where all the rest of the stones and all the dust particles are removed. During this process some seeds are removed so the pile of seeds and dirt particles is recycled back in by shoveling this pile back into the destoner.
6. The nuts are lifted up by a third bucket elevator and poured via a pipe to the final cleaner and sorter.
7. The seeds and shell fragments go on to the seed separator. Here a metal sheet angled about 120o away from the direction of motion has small enough gaps so that only the peanut seeds are let through.
8. The sorted seeds are collected in a wheelbarrow.
9. The wheelbarrow is transported to a final bucket elevator and the seeds are stored on a first floor balcony. This balcony has an opening to a pipe, which leads to an expeller.
10. The expeller uses steam to cook the seeds. The steam comes from a boiler that is fueled by cashew nut shells.
11. The expeller has two crushing chambers; the moving part is rotated, crushing the seeds. This gives the oil that is required. Also a "cake" is produced (containing the majority of the solid parts of the seeds).
12. The oil from the expeller is stored in a subterranean storage tank.
13. The oil is pumped up to a series of two filters. These filters contain layers of cloth and stop any solid parts of the seeds from passing.
14. The oil is a yellow colour, and is not a commercially viable product to be exported. It has to be sold to a refinery where it is:

    a) Treated with chlorine to bleach its colour to be transparent
    b) Treated with a base to neutralise its acidity
    c) Treated with Zinc to make it odourless

15. However it is sold to the local community in its natural and organic state.

For detailed photographs of the process described above please see the engINdia website.

The process explained above has some weaknesses to it. The owner of the oil mill claims that it barely makes a profit on the oil (0.5% profit margin, but this could be exaggerated; the economic facts are given below). The general layout of the design seems to be poor and the filtration can definitely be improved to produce a more marketable and sellable product. Any solutions posed must consider sustainability. The solution should also factor in the frequent power cuts in Pabal, as there seems to be no short term solution for them being implemented by the government.

As stated earlier, the owner of the oil mill is a leading figure in the Jain community. Therefore any solution should be sensitive to Jain beliefs (e.g. no animals should be harmed in the optimised design, so no animal oils can be used).

Full description of relevant infrastructure and resources available locally:

Pabal Oil and Dal Mills has been running for 40 years. It has an outlet shop in Pune and sells oil to the entire district around Pune. Some oil is also sold to the state capital, Mumbai, after a refining process to make it more marketable. The mill itself in Pabal consists of a mill shop, the main peanut processing plant, storage space for 20,000 sacks of peanuts (weighing 40 kg each) and another smaller processing plant that processes less popular seeds, such as odid, toor, and bajri seeds. The total site occupies approximately 1 acre, on the outskirts of Pabal.

The owner of the mill claims a 0.5% profit margin. Below are the economic factors relevant for this project:

- 1000 litres of water per day are used to create steam which is used in the expeller. In the wet season this water comes from the oil mill's own well. During the dry season, water costs Rs. 2 for 15 litres

- Peanut oil sells for Rs 50 /litre. This is the pure, natural product and is sold to a refinery (where the odour, colour and acidity are removed to make it more marketable) and the local community (where it is used straight away).

- Oil cake sells for Rs 11-13 /kg. This is sold to farmers for cattle feed. However it has the potential to be used for the generation of biogas.

- Peanut shells are sold for Rs 1.5/kg. These are sold to large companies (including multinational corporations such as Cadbury's) and used as a fuel or sold to poultry farms.

- To generate steam for the process, cashew shells are burnt. These cost Rs 1/kg.

- Peanuts cost 17-20/kg. The value can fluctuate highly due to availability over the market.

- The mill employs 45 people. Men are paid Rs 2500 /day. Women are paid Rs 1500 / day (Pabal average = Rs 2000 / day). Women are only allowed to work in the day and do non-physical jobs, such as working in the shop sorting seeds.

- The moving part of the expeller has to be reconditioned every month. The cost of this is negligible except the process is shut down for a day.

- The pipes have to be cleaned every 6 months. The cost of this is negligible except that the process is shut down for a couple of days.

- The machinery has a lifetime of approximately 10 years and this is due to improvements in the field replacing the present technology.

- The machinery works 80 kWhr-1*.

Useful background reading or resources:

See engINdia Website: http://www.engindia.net/resources.htm

Organisation Contact Details:

Name of Organisation	engINdia
Contact	engindia@mit.edu
Web site	www.engindia.net
Background information	engINdia exists to promote appropriate and sustainable engineering solutions in developing areas. Currently the program focuses on Pabal, Maharashtra, a rural village in India located 80 miles east of Mumbai. Pabal is home to Vigyan Ashram (see details below), an educational institution that focuses on rural technologies. The existence of Vigyan Ashram and Pabal's proximity to Mumbai made it the perfect starting point for engINdia. engINdia is a partnership between 6 students from the University of Cambridge, Massachusetts Institute of Technology (MIT) and the Indian Institute of Technology Bombay (IITB). An expedition was conducted during the summer of 2005 to the area of Pabal, Maharastra. There, the engINdia team worked with Vigyan Ashram and the local community to gain an understanding and appreciation of the development issues faced by rural India which could be tackled through engineering.
Name of Organisation	Vigyan Ashram
Web site	http://vigyanashram.com/
Background information	Vigyan Ashram is an educational institution situated just outside Pabal, Maharashtra, about five hours east of Mumbai. The focus of the institution is on rural education and enabling the rural population of Pabal and the surrounding areas to learn about technology and start their own businesses. The facility includes classrooms, labs, workshops, and living quarters for students. There is also a Fab Lab installed at the site (for more

information, see http://fab.cba.mit.edu/). VA is striving to become an internet service provider for the area and to that end many of the organization's activities are becoming focused on internet-related projects, such as internet kiosks for rural farmers. A few people at VA speak English, but some knowledge of Marathi or an interpreter will be needed in order to carry out work in the area.