Wastes from edible oil and fat industry of Karachi

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A field investigation has been carried out to characterise and quantify the waste being generated from a typical edible oil and ghee producing plant located at Karachi. It was found that 2.95 m³ of liquid waste was generated per tonne of oil and ghee produced and the waste generated from the factory failed with respect to BOD, COD, suspended solids, oil and grease. The pH, TDS and chlorides were lower than those of NEQS, whereas the values of Nickel and Iron are on border line.

Solid waste survey revealed that 9.1Kg solid waste was generated per tonne of oil and ghee produced, about 65 per cent solid waste was generated from the process areas while the balance i.e. 35 per cent from the non-process areas. Gaseous emissions from the flue gas of boiler meets NEQS requirements. Quality of the product conforms to specifications of Pakistan Standard Institution.

Introduction
Edible oil and fats are essential commodity items. The total current production in Pakistan is around 1.7 million tonnes annually with a growth rate of about 8 per cent per annum. The total production capacity of about one hundred and seventy edible oil and fat manufacturing units is around 2 million tonnes per annum.

The rapid industrial development of this sector in Pakistan has definitely contributed in environmental degradation, though its share is less than the other industries, however, no data was available for this industry which may indicate the environmental pollution aspects.

This study was undertaken characterise and quantify the wastes (liquid effluent, solid wastes and oil emissions) and their sources from a typical edible oil and fat industry located at Karachi.

Methodology
Field survey and sampling of effluents was carried out for five days in the factory when it was running on full capacity. During the survey, the liquid and solid wastes were quantified and characterised. Gaseous emission from the Boiler House and quality of final product i.e. Vanaspati ghee was also determined.

This factory had a large gravity settling tank in which all the liquid process wastes were equalised before discharging to the municipal sewers. For survey of liquid waste two location were selected, one from the combined waste streams of all the process sections entering the settling tank and the second sampling point was the final effluent discharge point entering the municipal sewer from the settling tank. The samples collected were immediately transferred to GCP Central testing laboratory adjacent to the factory where the analysis was performed right away. The average waste water generation was estimated using data of water supply consumption during process and possible losses. Parameters such as pH, BOD, SS, Fats and Oils, Chloride, Nickel and iron were analysed from the liquid effluent using ASTM methods [1] (ASTM, 1986). The details of methods is provided elsewhere [2] (Khan, 1997).

Survey of solid waste was carried out on the same days when waste water sampling was done. The daily weight and composition of solid waste were analysed from all process areas and other departments.

Flue gas samples were taken from the boiler for five days and also analysed in the GCP Central testing laboratory for carbon monoxide, Hydrogen sulfide and sulphur dioxide.

In order to ascertain that Vanaspati Thee was free from any contaminant, samples were taken from the storage area for five days and then the analysis of the same were carried out at GCP Central laboratory for parameters specified by Pakistan Standard Institution (P.S.I.). This study was completed during October 1996.

Result and discussion
It has been estimated that average daily water consumption at the plant under survey was 364 m³/day. The total waste water generated was estimated to be 295 m³/day, out of this about 227 m³/day of waste water was collected mainly from process and utilities areas in the gravity settling tank and thereafter discharge into the municipal sewer. While about 68 m³/day of waste water from canteen, washroom, mosque etc. was directly discharged in the municipal sewer. The balance about 68 m³/day of water was utilized in the process as steam and evaporated also. Thus the water consumption in the factory was 800 imperial gallons (3.64 m³) per tonne of oil and ghee produced, whereas the liquid waste generation was 650 imperial gallons (2.95 m³) per tonne of oil and ghee produced.

As shown in Table 1 the comparison of effluent analysis with NEQS reveals that fat and oil, BOD, COD, total suspended solids were much higher than the prescribed NEQS limits while iron content and nickel contents were marginally higher than NEQS. Iron might have come from the water distribution system which was quite old as the factory was established in early 1960's. Nickel content was
also slightly higher as it used as catalyst during the hydro-
genation of oil to vanaspati ghee.

The removal of emulsified oil and other biodegradable
organic present in the waste water can be accomplished by:

- Dissolved air flotation process.
- Biological treatment.

Due to space constraint in the factory the installation of
biological treatment system is practically not possible.
Thus dissolved air flotation treatment system is the only
practical method which can be installed in the factory to
reduce the pollutant load as much as possible and hence it
is recommended.

The average daily generation of solid waste in the edible
oil and fat factory under study was 914 Kg., which works
out to be 9.14 Kg per tonne of oil and ghee produced. From
average composition of solid waste as depicted in Table-2
it was evident that spent bleaching earth constituted the
single largest component of solid waste i.e. about 44 per
cent of the total solid waste generated.

Solid waste from edible oil and fat industry can be
segregated into two portions one as hazardous waste and
other as non hazardous waste (waste similar to municipal
waste). Spent nickel catalyst is considered as hazardous
waste based on its toxicity to aquatic life if it is disposed in
the waste water streams. The average daily generation of
spent Nickel catalyst was about 9 Kg, or 1 per cent of the
total waste generated. It was stored in the every three
months a contractor purchased it to manufacture inferior
quality soap after extracting oil from spent Nickel catalyst.
Spent bleaching earth contained about 30 per cent oil
content is of pyrogenic nature i.e. when exposed to the
atmosphere at warm ambient temperature will spontane-
ously reach ignition temperature. Oil is recovered from the
spent bleaching earth after its treatment in a vessel where
steaming is carried out along with a mild caustic solution.
The oil so recovered contains 80 - 90 per cent total fatty
mater and is used in laundry soap manufacturing. Thus
the oil content of the spent bleaching earth is lowered from 30
to about 10 per cent. This treated spent bleaching earth is
also purchased by the contractor who after recovering
further 3-4 per cent oil prepare inferior quality laundry
soap. At the end the spent bleaching earth almost free from
oil content is dumped as waste for land filling.

Tin cuttings obtained from the tin manufacturing plant
constitutes about 5.5 per cent of total solid waste gener-
gated, these cuttings are also sold to a contractor. Used filter
cloth which can not be further used for filtration purposes
constitutes also about 5.5 per cent of total waste generated.
After steam washing this filter cloth is used cleaning the
process areas the storage areas of the finally packed prod-
uct.

About 25 per cent of solid wastes consisting food
waste, paper, plastics etc was dumped off to KMC dumping
areas, while the remaining 75 per cent of waste having
paper, wood, plastic, filter cloth and spent bleaching earth
was being sold to outside contractors.

Natural gas is used as fuel in firing the burners of boilers.
As shown in Table 3 the analysis of fuel gases carried out
shows that all parameters tested i.e. carbon monoxide,
sulphur-dioxide and Hydrogen sulfide were well within the
NEQS limits, other constituents of the flue gases could not
be detected.

Conclusion
Following conclusion can be drawn based on the study
carried out and data obtained from the field survey.

- The liquid waste of 295m3/day was generated per tonne of
  production of Thee and REFERENCE cooking oil.
- The fats and oil, BOD, COD and suspended solid
  content in liquid effluent were substantially higher then
  the NEQS (National Environment Quality Standards).
- Nickel and Iron content in the waste water were ranging
  from 0.4 to 1.5 and from 1.7 to 4.2 ppm respectively.
  These values are marginally higher than the NEQS
  limits.
- The average solid waste generation rate was found to be
  914 Kg per day (9.14 Kg per tonne of ghee and cooking
  oil manufactured) consisting of about 65 per cent as
  industrial solid waste from process areas and about 35
  per cent of municipal waste from other non process
  areas. About 25 per cent waste of the total waste was
disposed to K.M.C dustbins as municipal waste, the
remaining being sold along with the processing waste.
- The concentration of Carbon monoxide, sulphur diox-
  ide and Hydrogen Sulphide in the gaseous emission was
  within NEQS limits.
- Nickel contents in the final product was less then 0.2
  ppm, thus confirming PSI quality standards.

Acknowledgement
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neering and Technology, Karachi.

Reference
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itution of Environmental Engineering and Research,
N.E.D. University of Engineering and Technology,

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University of Engineering and Technology, Karachi -
Pakistan.

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Table 1. Summary of results of effluent analysis

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameter Mg/I (ppm)</th>
<th>Observed range (During 5 days analysis)</th>
<th>NEQS</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>8.5–9.3</td>
<td>6–10</td>
<td>Meets NEQS</td>
</tr>
<tr>
<td>2.</td>
<td>BOD</td>
<td>1520–1740</td>
<td>80</td>
<td>Exceeds NEQS limits</td>
</tr>
<tr>
<td>3.</td>
<td>COD</td>
<td>1730–1920</td>
<td>150</td>
<td>Exceeds NEQS limits</td>
</tr>
<tr>
<td>4.</td>
<td>Suspended solids</td>
<td>1930–2240</td>
<td>150</td>
<td>Exceeds NEQS limits</td>
</tr>
<tr>
<td>5.</td>
<td>Total dissolved solids</td>
<td>2200–2865</td>
<td>3500</td>
<td>Meets NEQS</td>
</tr>
<tr>
<td>6.</td>
<td>Fats, oil and grease</td>
<td>1630–1915</td>
<td>10</td>
<td>Exceeds NEQS limits</td>
</tr>
<tr>
<td>7.</td>
<td>Chlorides</td>
<td>650–780</td>
<td>1000</td>
<td>Meets NEQS</td>
</tr>
<tr>
<td>8.</td>
<td>Nickel</td>
<td>0.4–1.5</td>
<td>1</td>
<td>Exceeds NEQS limits</td>
</tr>
<tr>
<td>9.</td>
<td>Iron</td>
<td>1.7–4.2</td>
<td>2.0</td>
<td>Exceeds NEQS limits</td>
</tr>
</tbody>
</table>

Table 2. Average composition of solid waste (per cent) (Basis 5 days sample analysis)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Solid waste</th>
<th>NEQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Spent bleaching earth</td>
<td>44</td>
</tr>
<tr>
<td>2.</td>
<td>Food</td>
<td>19.5</td>
</tr>
<tr>
<td>3.</td>
<td>Paper</td>
<td>11.5</td>
</tr>
<tr>
<td>4.</td>
<td>Cotton/duster</td>
<td>8.5</td>
</tr>
<tr>
<td>5.</td>
<td>Tin cutting</td>
<td>6.5</td>
</tr>
<tr>
<td>6.</td>
<td>Fitter cloth</td>
<td>5.5</td>
</tr>
<tr>
<td>7.</td>
<td>Wood</td>
<td>2.5</td>
</tr>
<tr>
<td>8.</td>
<td>Plastic</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>Spent nickel catalyst</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3. Gaseous emissions analysis from boiler

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Test</th>
<th>Observed range (During 5 days)</th>
<th>NEQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Carbon monoxide (mg/Nm³)</td>
<td>28 – 84</td>
<td>800</td>
</tr>
<tr>
<td>2.</td>
<td>Sulphurdioxide (mg/Nm³)</td>
<td>16 – 42</td>
<td>400</td>
</tr>
<tr>
<td>3.</td>
<td>Hydrogen Sulphide (mg/Nm³)</td>
<td>Traces</td>
<td>10</td>
</tr>
</tbody>
</table>