MANAGEMENT OF WASTE OIL IN BOTSWANA AND THE POSSIBILITIES OF ENERGY RECOVERY FROM WASTE OIL

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Since independence, the economy of Botswana has been undergoing a rapid transition from one in which the majority of the people depend on traditional agriculture and pastoralism to one in which formal sector employment predominates. This is partly reflected by rapid increase in vehicle population. Because of these changes, the country started to experience environmental problems. Unfortunately from the time of independence until late eighties, the level of environmental awareness in the country was very low, and therefore waste minimisation and reduction of environmental impact procedures were never in place.
To date, many organisations in the country still seem not to be committed to reducing and disposing their wastes in environmentally friendly manner. The need to reconcile development with environmental concern, thus sustainable development, is vital.

For the country to achieve that, an introduction of environmental impact assessment in Botswana is essential, and thus, the main thrust of the current investigation is to determine the level of concern about environmental problems posed by waste engine oil in various organisations in the country. Management of various organisations were interviewed on their methods of waste engine oil disposal. It was found that the disposal of waste engine oil by many organisations is resulting in serious environmental problems.

1. INTRODUCTION

To foster the principles of sustainable development in the population at large, it is important for every community to minimise the volume of waste and especially that part which has to be disposed at the end of design life. In general, this can be achieved by minimising the production of waste, and recycling or re-use of the waste materials. However, not all types of wastes generated by the community may fulfil all the above three methods of waste minimisation. Waste engine oil is one good example.

It is interesting to note that the volume of waste engine oil produced by the community for a given time increases with the increase in the number of vehicle manufacturers, engineering plants and garages.
From the environmental viewpoint, waste engine oil is a major hazard if not reclaimed or disposed of in an environmental friendly manner. It may contain heavy metals such as arsenic, lead and mercury which can harm sea and human life even at low concentrations. It can enter the natural environment with disastrous results.
As stated earlier in this report, the volume of waste engine oil may not be reduced through waste minimisation or re-use. The best practical ways of reducing the volume of waste engine oil would be to increase the usage life span of new oil, and also to improve the filtration system by introducing high surface area filters with long life. Clearly the question of increasing product life and improvement of filtration efficiency is closely related to both national, and environmental policies of oil companies and other related companies, such as filters manufacturers.

It is important to note that re-use of waste engine oil, mostly in some non-engineering applications may pose more environmental problems, when compared with the environmental profile associated with using new oil in many engineering activities. In Botswana for example, the study revealed that individual farmers, use large quantities of used oil in various agricultural activities, such as application of waste engine oil on farm animals for the control of ticks. The re-use of waste engine oil by individual farmers in Botswana has never been given much consideration, and as such, it may be posing serious environmental problems, such as ground and surface water (rivers, dams) pollution. In such situation, the move towards the protection policies aimed at the prevention of adverse changes is vital.

2. METHODS OF WASTE ENGINE OIL DISPOSAL IN BOTSWANA.

The country's largest volume of waste oil comes from vehicle service centres. To date, there are an estimated 115 thousand vehicles registered in the country. This figure is expected to grow at an average of 5000 vehicles per year to 155 thousand vehicles by the year 2005 (1). The study revealed that, there was no uniformity in waste engine oil disposal practice. Different organisations employ different methods of waste engine oil disposal. Many of the disposal practices were found to be environmentally unfriendly. In general it was found that individuals, especially farmers, collect waste engine oil from many service centres for general use including application of waste engine oil on farm animals for the control of ticks and

the treatment of fencing poles as a protecting measure against insects. A firm conclusion could be drawn that many organisations preferred this method because it was cheap and the liability should any degradation of environmental damage occur was automatically transferred to the final user.

Figures 1 and 2 show the common methods of waste engine oil storage systems, which most vehicle servicing centres were found to use in preference to modern storage facilities. It is interesting to note that these storage systems were found to cause serious environmental problems resulting from waste engine oil spillage and the overflow of waste engine oil from open storage drums especially during a heavy rainfall. A typical capacity of mobile waste oil tanker shown in figure 1 was estimated as 2250 litres. It was found that in some centres, individual farmers may collect an approximately 2250 litres of waste engine oil. It was not known how the individual farmer disposed any excess waste engine oil. In view of the complexity of the environmental pollution interaction between land, watercourse, and air, a conclusion could be drawn that the uncertainty of excess waste oil disposal option, which may be carried by many farmers, could be causing serious environmental degradation in Botswana.

Considering the open 210 litres storage drum method, the study revealed that in some areas, a large volume of waste engine oil ended up in places like rivers and dams. Figure 3 shows the storage facility in the City of Francistown Town Council. It was constructed to lead the flow from open storage drums into Tati River. It may be concluded that quite a large volume of waste oil end up in places like Shashe dam increasing environmental degradation of the area, and putting aquatic life at serious risk.

In places where there was no spillage and overflow measures are provided, like in Gaborone City auto workshop, it was found that waste engine oil permeated into the soil for up to more than a meter. Figure 4, which show a pool of waste engine oil on ground at Gaborone City auto workshop. It is worth noting that environmental degradation resulting from poor waste oil management as shown by figures 1, 2, 3, and 4 may have negative impacts on the economic value of the affected area.

To enhance sustainable economic activities in Botswana, substantial changes regarding waste management approach is vital.

3. DISPOSAL OF OIL FILTER ELEMENTS IN BOTSWANA.

Another area of environmental concern is the disposal of oil containing waste oil filters cartridge. A large volume of used filter cartridges is discarded in the country each year. The volume is expected to increase with the increase in vehicle population and stationary engines. Figure 5 shows used oil filters at the end of their useful life span. The disposal method in place is by landfill. This has been the practice since the introduction of solid waste disposal by landfill in the country in the early eighties. The disposal of oil containing wastes by landfill might seem to be the simplest and cheapest method of solid waste disposal, but the method may result in a serious environmental degradation like ground water pollution.

It is pertinent to mention that old oil filter elements may retain up to 50ml or more of waste oil depending on its size during oil replenishment and oil filter changes. This quantity of waste oil ends up in landfill sites. Considering the projected average growth rate of 5000 vehicles per year, the quantity of waste engine oil which may ends up in landfill sites in Botswana would be enormous in the near future, if the landfill continues to be the only disposal route in the country.

To enhance sustainable development in the country, it would be necessary for Waste Management Authority to encourage pre-treatment of the used oil filter elements before their final disposal. In practice, this means incinerating the type of solid waste shown in figure 5. It is worth noting that incinerating filter elements would ensure recovery of ferrous metals, which may be baled and sold for scrap, giving a valuable return, which may be credited against operating costs.

4. FEASIBILITY OF ENERGY RECOVERY FROM WASTE ENGINE OIL.

Although waste oil is easily recovered, as it is the case in many countries, the quantity of recycled oil found, at vehicle servicing centres is small. This is largely because of the degraded quality of recycled oil. It is interesting to note that once the material has been recycled, it is generally of lower quality than the virgin material and this severely limits its applicability. This may be the case with the recycled oil.

In the UK for example a large quantity of recycled oil from the recycling plants, goes mainly to quarries for use in drying sand, gravel and roadstones.

It is pertinent to mention that the input energy and the environmental profile associated with recycling a unit mass of waste engine oil in comparison with the

stoichiometric combustion of a unit mass of waste engine oil could be enormous. In such a scenario, the concept of waste engine oil-to heat looks attractive.

The method of disposal is based on the combustion of waste engine oil, recycles the thermal content present in waste engine oil to produce power and heat. The potential of engine waste oil as a fuel is shown by its calorific value of about 42.9 MJ/kg (2) thus approximately 43% more then that of moisture free coal.

Botswana with an estimated 115 thousand vehicle at the end of 1997 would be estimated to yield approximately 2.42 million litres of waste engine oil, assuming that in average a vehicle produces approximately 21 litres of waste engine oil annually. If the total waste engine oil generated were converted into energy, from equation 1, it would yield about 4.2 Mt coal equivalent.

$$Q_{energy} = \frac{M\,oil * CV\,oil}{CV\,coal} \quad (1)$$

Where M oil = Oil quantity
CV oil =Oil Calorific Value
CV coal = Coal Calorific value

It can be seen that if this waste engine oil is converted into heat and / or power a considerable saving in coal would be made. Whether this saving in the use of coal would also lead to a saving in money would depend on the capital and running costs of the plant necessary to prepare and burn the waste engine oil compared with the current degradation of the environment, which in the near future may cost the government a large amount of money in treating such components as contaminated land.

Already, the technology and reliability of waste engine oil-to-energy is proven worldwide. Figure 6 shows a heavy oil burner, which could be used in burning waste engine oil. Heavy oil burners are fully packaged. The main components of a typical unit include integral oil heaters, pumps, circulation and purging systems. Table 1 shows some of the available range of burners and their fuel consumption rates. The specifications of burners are used as a representation of the available burners. It may be justifiably thought that the availability of heavy oil burners point to great possibilities for the combustion waste engine oil.

From table 1, the use of burner model range AW 5 for example, would be expected to consume approximately 1.5 million litres of waste engine oil annually, assuming the annual operating time of 8760 hours. The use of this burner would yield up to 1.5 MW, 2391 kg/hr steam and 1.29 * 10^6 kcal/hr of hot water.

Some previous studies (3) has shown that the energy consumed by a nation is directly proportional to its standard of living. It has been established that the under-developed nations use about 0.5 kW per person compared with a rate in the developed nations of between 5 and 10 kW. From the above energy values, it may be concluded that 1.5 MW would be sufficient to supply up to 3000 people or more in Botswana for example.

5. TYPICAL INDUSTRIAL APPLICATIONS

Applications for such a plant would be in large hospitals where there is substantial and continuous demand for heat, hot water, steam and power. Other possible areas would be water treatment plants, (sewage plants) which in most cases operate 24 hours per day, and have a continuous electrical demand from the pumps. Based on the above technical evidence, it may be expected that such systems if implemented would be cost effective in cutting down the present running cost encountered by many government and non-government organisations which generate steam from coal for their daily activities.

6. CONCLUSION

Although the dumping of waste oil into soil or water is prohibited in Botswana like in many countries, the study revealed that the enforcement is very weak.

From figures 1, 3 and 4, it may be concluded that neither the government organisation nor the private organisation management system is concerned with the detriment of the environment as a result of their poor handling and storage methods of waste engine oil.

7. RECOMMENDATIONS

- Authorities should with immediate effect construct national storage depots for waste oil in all towns and big villages where engineering activities, which generate waste oil are located.
- Prior to the improvement of enforcement procedures, authorities should seek to improve the quality of data on reclamation and recycling of waste oil.
- Authorities, which are considering undertaking energy-from waste schemes will note that there is, need for thorough costing of all aspects of such

projects, and in particular the importance of securing an assured market for the products.

- Both non-government and government organisations be seriously encouraged to carry out environmental impact assessment (EIA) exercise for all their economic activities. The EIA may increase the environmental awareness of the management and their employees at large.
- Industries which use waste oil as fuel should work jointly in seeking the best possible ways of increasing the level of recycling opportunities and seek the best practical solutions regarding collection and transportation of waste oil to the collection centres.

8. REFERENCES

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Figure 1
Mobile storage waste oil tank

Figure 2
Open drums 210 litres

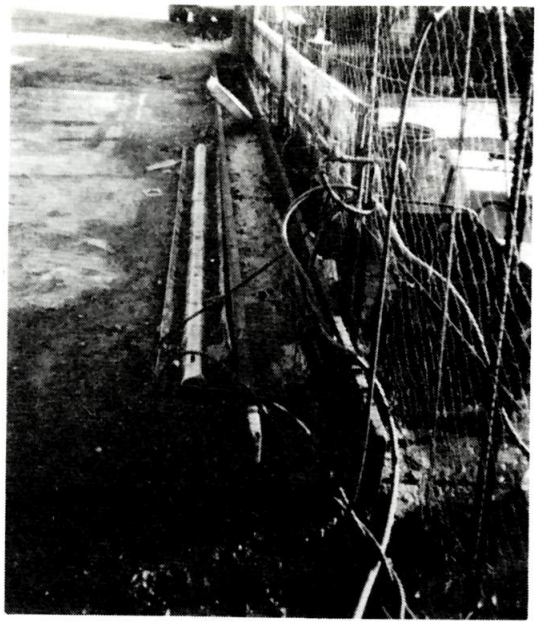

Figure 3
Channel leading waste oil into the river

Figure 4
A pool of waste engine oil at Gaborone City auto workshop

Figure 5
Filters at the end of their useful life span

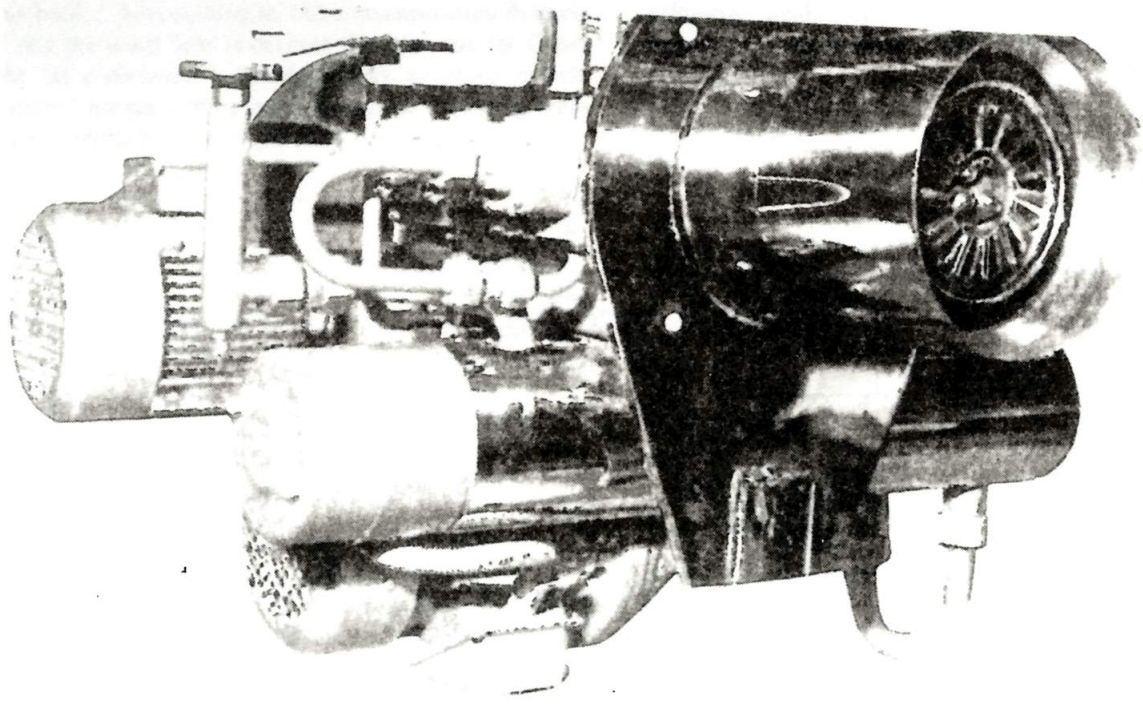

Figure 6
Heavy oil burner

Table 1

DESIGN SPECIFICATIONS OF SOME HEAVY OIL BURNERS AVAILABLE IN THE MARKET

BURNER MODEL & RANGE	MAX. FUEL CONSUMPTION OIL-CLASS 'G' LITRES / HOUR	APPLICATION OUTPUT AT 80% GROSS EFFICIENCY		
		Steam (kg/hr)	Hot water (Kcal/hr ($*10^6$)	MW
AW 5-11	170 - 375	2391 - 5260	1.29 - 2.83	1.5 - 3.3
AW 12-20	414 - 659	5802 - 9245	3.12 - 4.98	3.6 - 5.8