The Nucleus, **46** (3) 2009: 279-288

The Nucleus
A Quarterly Scientific Journal of Pakistan
Atomic Energy Commission
NCLEAM, ISSN 0029-5698

INDUSTRIAL WASTE MANAGEMENT – A CASE STUDY AT ATTOCK OIL REFINERY LTD., RAWALPINDI

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As far as waste is concerned, industry has a two fold position: on the one hand industry produces waste during the production processes and on the other hand most of the industrial products become waste after being used. From environment perspective waste management and minimization at the source has become important issue all over the world. Waste minimization leading to cleaner production is the process and the policy of reducing the amount of waste produced by Industry at the source and remaining should be managed.The core objective of this research paper is to examine the impact of waste minimization, waste management and the planning of effective waste utilization that increases organizations profitability and green image. The case study will present the Recycle, Reuse, Reduce strategy that waste management is not only necessary to keep the environment healthy but it also brings the financial savings to the organization. It is obvious that there is significant relationship between waste management and profitability. Attock Refinery Limited (ARL) has done significant work in the field of industrial waste management. The stratified sampling has also used during a survey to gather primary data i.e. congregated by administering questionnaires to employees of different departments that shows positive attitude towards waste minimization and management. The interventions regarding industrial waste management are in full practice at ARL to meet the National Environmental Quality Standards. In 1993, prominent step has been taken to address the environmental issues and waste management. After carrying out the detailed survey of effluent waste water system during 1995-1996, Effluent Treatment Plants were installed to meet the NEQS. Keeping the continuity of efforts “Zero Discharge” of effluent waste from the refinery was targeted. This project is recycling the waste water resulting environment conservation and saving money that was being spent for water pumping from remote sources and in storage facilities. The implementation has been planned in different phases to achieve the goal. In first phase cooling towers blow down water (96,000 liters/day) and drinking water treatment plants back wash water is being recycled and used for fire water, washing the plants area floors and gardening purposes. The work is in progress to recycle and reuse all refinery waste water. Bioremediation is being carried out of oily sludge recovered during the cleaning of the crude oil and products storage tanks. It is the safest technique in the world for such type of hazardous waste. The above technique is also being implemented for crude oil / product spillage during transportation. The waste from refinery and hospital is being incinerated in three stage incinerator meeting NEQS and minimizing impact on the environment. It is concluded that proper management of all type of wastes, implementing cleaner production techniques to minimize waste at the source contributes not only to protect the environment but also increases the profitability and meet corporate social responsibility.

Keywords: Waste management, Minimization, Cleaner production, Zero discharge

1. Background

Every developmental activity is accompanied with the generation of waste. Waste is produced as a result of all the industrial processes. Waste management is the process by which products and by-products generated by industry are collected, stored, transported, treated, and disposed of, recycled or reused. Different types of waste are generated at each and every step of production process, i.e. transformation of inputs into output involves the utilization of resources. The efficient use of inputs controls avoidable losses and yields better productivity. As far as waste is concerned, industry has a two fold position: On the one hand industry produces waste during the production processes; on the other hand most of the industrial products become waste after being used. Mainly, there are three main types of waste which is generated like solid, liquid and gaseous wastes.

With the advent of industrialization, the quantity of wastes added to the atmosphere became an alarming issue as the wastes which are being released are greater than the carrying capacity of the environment. Consequently, this greater production of waste is leading to the inefficient use of resources also it doesn’t give enough put time

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span to the resources to get replenish and also causing great threats to the environment and humanity. The quantity of the waste generated usually depends on the amount of production and on the type of process used. With current trends of industrialization, wastes and pollutants are released faster than the earth can absorb them, and natural resources are consumed faster than they can be restored. If better development is to be achieved, production processes, products, and services have to be reoriented towards new patterns, in order to both alleviate environmental stress and bring better industrial productivity. This requires the development and use of new policy and management tools by the industry, as well as the development and use of environmentally sound technologies with a focus on cleaner and safer technologies that prevent pollution and make efficient use of raw materials. Attock Refinery Ltd. (ARL) is being presented here as a case study that elaborates the procedures which they have opted for waste management. ARL is successfully running many projects on waste management which can be taken as role model like 'Zero Effluent Discharge' for the purpose to reduce, reuse and recycle the waste water that is being produced as a result of industrial activity

Pakistan which initially had no strong industrial background and industries were established in the regime of non-environmental legislations in the country. National Environmental Quality Standards (NEQS) were promulgated during the year 1993 to protect the environment.

2. Waste Management at ARL

Attock Refinery limited (ARL) is pioneer in crude oil refining in the country with its operations dating back to 1922 and with the passage of time ARL's plants have been gradually upgraded to remain competitive and meet new challenges and requirements. It was then incorporated as a Private Limited Company in November 1978 to take over the business of the Attock Oil Company Limited (AOC) relating to refining of crude oil and supplying of refined petroleum products.

ARL produces Premium Motor Gasoline**,** High Speed Diesel**,** Kerosene, Furnace Fuel Oil, Low Sulfur Furnace Fuel Oil**,** Jet Fuels (JP-1, JP-4 & JP-8)**,** Paving Asphalt (various grades)**,** and Cut back Asphalt (various grades), Polymer Modified Bitumen, Mineral Turpentine Oil, Light Diesel Oil, Naphtha, Liquefied Petroleum Gas, Jute Batching Oil, Solvent Oil and Premium JBO [1] .

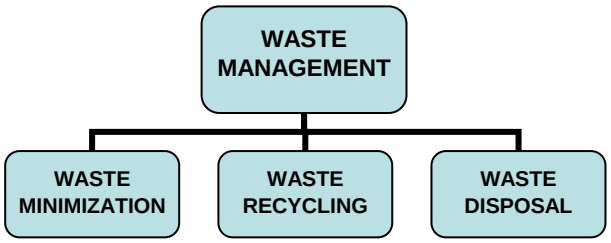
ARL has done significant work in the field of industrial waste management. The interventions regarding industrial waste management are in full practice at ARL to meet the NEQS. The waste generated at ARL is minimized by applying cleaner production techniques. Zero Effluent Discharge project is playing the role to reuse the waste water generated from car washing, kitchen water, cooling water and drinking water plants. The objective of present case study is to examine the relationship between waste management and environment protection leading to profitability. Recycle, Reuse, Reduce strategy applying to waste management is not only necessary to keep the environment healthy but it also brings the financial savings to the organization [1].

Refinery has the unique capability and distinction of processing different quality of crude oil ranging heavy to light produced from various fields across the country.

3. Aspects of Waste Management at ARL

In ARL, waste management procedures based on following three main aspects.

1. Waste Minimization: the best and most cost effective method.
2. Waste Recycling: (including Re-use and Recycling): where minimization isn't possible.
3. Waste Disposal: the last resort and most costly option



Among the above aspects, research mainly focuses on the recycling as it is the most economical and it can be a new source of raw materials. Waste derived raw materials, in addition to primary resources become an optimized way of raw materials requirements. This increases the productivity and profitability.

3.1. Waste minimization

a. At ARL a closed sampling system has been installed in operational areas which help to minimize the quantity of oily water reaching the treatment/recovery system. According to this sampling system no oily waste generates while sample is being collected.

b. Storm water drains have been constructed to segregate storm water from effluent stream. This has resulted in significant reduction of the load at Effluent Treatment Plant (ETP) and has increased many folds the efficiency of treatment plant in recovery and exit of oily waste outside oily drain system.

3.2. Waste recycling

Modern waste management techniques are based on the concept of recycling. Recycling is the reprocessing of waste materials to become reusable for the process.

In this way we can increase output, optimize energy usage, utilities, also lowering the pollution by reducing the needs for "conventional" waste disposal, and thus minimizing green house gas emissions.

In this respect reuse of effluent water is discussed separately under liquid waste.

Waste disposal

Disposal of waste as mentioned earlier is sometimes an expensive and difficult option. An example could be nuclear waste. Disposal of solid waste at ARL includes oily sludge, metallic scrap etc. Techniques used are discussed in detail in solid waste management.

4. Waste Types and Management

Generally the waste generated in the refining sector is of three types. At ARL, all the three types of waste like solid, liquid and gaseous are generated but the majority of waste is liquid.

4.1. Liquid waste

The refinery discharges effluents containing different types of pollutants, both organic and inorganic, directly into streams and canals which comes under liquid waste. These discharges can render the water body unfit for irrigational use, a threat to aquatic as well as terrestrial biodiversity, livestock or human consumption and aesthetics. The typical pollution parameters followed at petroleum refineries in Pakistan are effluent flow, temperature, pH, BOD, COD, TSS, oil and grease and phenolic compounds. ARL is fulfilling all the parameters as mentioned in Table 1.

Table 1. NEQS parameters and ARL effluent monitoring report.

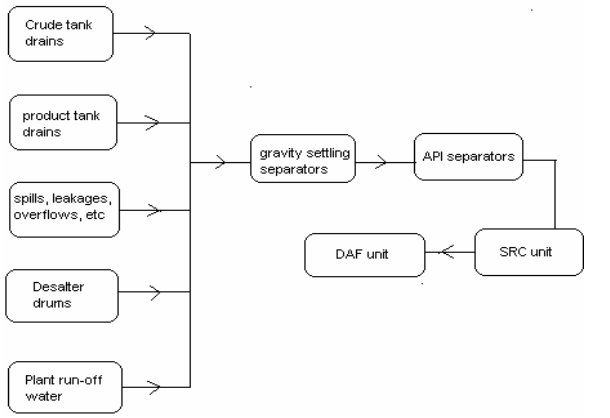
Parameters	Unit	NEQS Limit	Effluent at ARL
Temperature	^{0}C	40	31 - 37
Oil & Grease	ppm	10	8 - 10
pH	-	6 - 9	7.3 - 8
COD	ppm	150	95 - 345
BOD5	ppm	80	22 - 75
TSS	ppm	200	53 - 109
Phenol	ppm	0.1	0.04 - 0.05

Liquid waste is oily water and non oily waste water. The main sources of non oily waste water are Cooling Towers, Boilers Blow Down water, Car Wash Waste Water, Drinking Water, Treatment Plant Waste Water, and Kitchen Waste Water. Liquid waste is recycled at ARL for the purpose of environment protection, conservation and financial savings.

4.1.1. Oily waste water

A huge volume of oily waste water is generated at refinery. Desalters are the main sources of oily waste water. The other sources of oily waste water are drains of crude oil and petroleum product tanks, spills, leakages, plants' equipment and floor washing. All the crude oil and some of the product tanks contain some water at the bottom which drains periodically. Since the drained water is contaminated with oil coming from tanks which needs to be removed. This Oily waste water cannot be drained out from refinery without proper treatment because hazardous polluting agents imposes potential health, safety and environmental risks to human being, biodiversity, land, aquifer and climate. Similarly it also contains objectionable odors and unacceptable aesthetic appearance. Keeping in view all these facts, oily waste water must be treated at Effluent Treatment Plant to comply with the National Environmental Quality Standards. So at ARL, the final effluent leaving the refinery is in accordance with National Environmental Quality Standards. Effluent Treatment Plant (ETP) recovered about 3,600 tons of Furnace fuel oil per year. A typical block

diagram of oily waster water treatment is given in figure below.



4.1.2. Non-oily waste water

The main sources for non-oily effluent are as follows;

- Boilers blow down water
- Softener units regeneration waste water
- Cooling towers blow down water

The other sources for the non-oily waste water include kitchen waste water, drinking water treatment plant, car wash water and Area floor washing water.

The main projects carried out at refinery for handling liquid effluents are given below:

5. Projects for Handling Liquid Effluents

5.1. Zero effluent discharge project

- ARL initiated “Zero Effluent Discharge” project with zero budget
- utilizing the concept of three R’s.
- Reduce
- Reuse
- Recycle

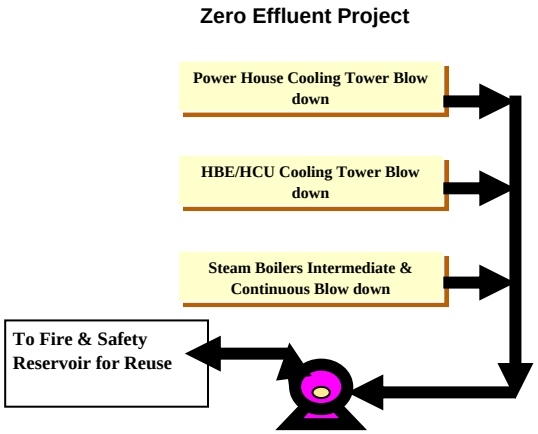
In Zero Effluent project, Non-Oily Effluent from Cooling Water and Power Plant has been successfully Recovered, Recycled and Reused. Below is the quantity of recovered water at both plants:

A- Boiler + Softener Blow Down Water 40-60 m^3 /day (11,000 IG/day)

B- Cooling Tower Blow Down Water 96-100 m^3 /day (21,145 IG/day)

In this way, ARL is saving huge quantity of water through this project, which can be utilized to fulfill other water demanding processes.

Now if this huge quantity of water is recovered, recycled and reused, the amount of water saved can be tremendous. The saved quantity can be utilized for other useful purposes and at places where water is needed and sources are not present.



The total water consumption of the Attock Refinery Limited is 269.8 Million gallons per year. Therefore, the situation demands recovery of maximum water from refinery processes (Table 2).

On the other hand it stops 180,000 gallons per day of wastewater polluting the natural watercourse. Zero effluent discharge project contributing a lot to conserve water, cut short mixing of industrial polluted with natural water and halt further exploration of water from soil which ultimately returns in the form of significant environmental as well as financial benefits to the industry.

Table 2. Savings from water conservation.

S. No.	Quantity	Gross Saving	Net Saving
01	Per Day (Rs.)	2640/-	1848/-
02	Per Year (Rs.)	950400/-	653,970/-

5.2. Kitchen waste water treatment

The daily consumption of Refinery kitchen water is about 4,000 litres per day and the amount of waste water generated is about 2,100 litres per day. Refinery canteen wastewater after screening is collected in storage tank. This wastewater is then pumped from storage tank to Biological treatment section. In this section aerators are carrying out aeration and aerobic treatment takes place in the presence of activated sludge. After this, water reaches in coagulating/flocculation section and then in settling section. From settling section treated water comes in storage section after filtration. Treated water can be used for gardening purpose from storage section. First, the treated water quality was checked in laboratory and physically plants were irrigated on experimental basis. The treated water quality has been found suitable for gardening.

Kitchen waste water treatment project at ARL

5.3. Drinking water treatment plant waste water recycling

Water quality is being continuously degraded by widely spread of organic and inorganic waste contamination of surface and ground water due to improper waste management and resulting organic and inorganic pollution. Drinking Water Treatment Plant of Attock Refinery Ltd. is producing 1,000 gallons per day of wastewater drained from backwash of sand filters. The water is being reused as garden water after treating it at a settling pit. This has saved an equal amount of fresh water to be used for gardening purposes.

Drinking water treatment plant waste water recycling

5.4. Car wash waste water

Motor vehicle is an expensive piece of equipment and to prevent it from rust and corrosion, it is essential to wash it frequently. Washing of vehicles requires a lot of water. In areas, where enough potable water is not available, it becomes difficult to justify the use of fresh water for vehicle washings. Since car wash can tolerate dissolved solids, systems have been developed elsewhere to recycle the car wash water up to 90% of the requirement. The final rinse to the vehicle is given with fresh water to remove the traces of dissolved salts. The system not only economizes on fresh water requirement but also reduces the amount of detergents used, as a good part of detergent is recycled. The system of car wash at ARL has capacity of 20 liters per minute. Car wash Waste Water is used for the same purpose after having physical separations.

Car wash waste water recycling.

5.5. Drip irrigation system

Drip irrigation system is one of the most efficient, advances, reliable, portable and extendable water conservation system. A well-designed drip irrigation system loses practically no water to runoff, deep percolation, or evaporation. It reduces water contact with crop leaves, stems, fruit and unnecessary soil surface.

Thus conditions may be less favorable for the onset of diseases, epidemic spread of diseases and growth of unwanted plants. Irrigation scheduling can be managed precisely to meet crop demands, holding the promise of increased yield and quality. This system can also be used for fertigation of crops. It contributes to reduce weed growth in the orchards, thus, play an important role to decrease rate of crop production. This system is much suitable for areas of scarce water sources. Advanced vegetable farming like tunnel farming and off season vegetable farming are incomplete without drip irrigation system. This system is adjustable at each and every plant and quantity of water may be managed according to requirement of plants that alters with the age of plants and weather conditions.

Drip irrigation system worked very successfully in citrus fruit orchard in past covering an area of about two acres, but now it is non- functional for the sake of maintenance activities required at the site. At ARL we do use kitchen waste water after recycling in drip system. While talking about the taxonomy of this conservation system, a water pond is used as reservoir and water pumped to a network of main channels and sub channels through a high pressure electrical pump.

5.6. Water sprinkling system

Another project of ARL for water conservation and reduction in manpower is water sprinkler system in the lawns, parks and play grounds of the company area. It ensures the equal distribution throughout the area while using optimized quantity of water. This system contributes in maximizing the profitability as less labor force is used and cost of energy used to run it is lower than the labor cost. This system consists of three major components; a water reservoir, a small water pump attached with a network of distribution pipes and spray guns or sprinklers, whatever required. For play grounds mostly spray guns are used while for lawns pop-up sprinklers are the best known options. It requires one time capital investment and has no maintenance cost, if handled carefully. This system is currently installed at lawns and play grounds.

6. Solid Waste

The production of paper, rubber, metals, plastics and ceramics has been steeply increasing over the last few decades as a consequence of industrialization and increasing population which has in turn resulted in an increase in the generation of solid waste both in developed and developing countries.

In the Industrial processes, the nature of solid waste depends upon the type of raw material used, manufacturing processes, including hazardous and non-hazardous solid waste. For example, in petroleum refinery, typical solid waste pollutants are used catalysts, oily sludge, contaminated sludge, used drums and metal scraps etc.

The solid waste which is produced at ARL mainly comprises of hydrocarbon sludge, oily rags, mild steel scrap, mild steel vessel, used tank plates, cast iron, steel scrap, brass and copper scrap, damaged rusted pipes, polythene bags, rubber scrap, plastic drums, paper waste, asbestos sheet, computer monitors, firewood and other plant source waste.

ARL has initiated an Integrated Solid Waste Management to control generation, storage,

collection, transport, processing and dispose of solid wastes in a manner that is in accord with the Pakistan environment policy. Waste is managed in four steps; segregation at source, collection, transportation and final disposal. At source, the waste is disposed and segregated in colour- coded waste bins. The particular color coding for different types of waste is as mentioned below:

Black	Oily rags
White	papers
Green	plastics
Red	glass
Yellow	leaves

Solid waste at ARL has been categorized in two types:

6.1. Hazardous waste

The hazardous waste is generally defined as "Any waste or combination of waste that may cause a substantial danger, now or in future, to human, plant or animal life, and which therefore cannot be handled or disposed off without special precautions". Oily waste constitutes oily rags including gloves, overalls (dangrees) and the clothes used to clean the machinery. Hazardous waste also includes asbestos sheet, contaminated polythene bags, oil contaminated grass, powdered chemicals and polymers.

6.2. Non-hazardous waste

Non- hazardous waste is that which is comparable to normal domestic garbage and poses no greater risk. Such waste includes all organic and inorganic materials like paper and cardboard, packaging and food waste. Following waste is sold out for recycle and reuse: mild steel scrap, mild steel vessels, used tank plates, cast iron, steel scrap, brass and copper scrap, damaged rusted pipes, rubber scrap, plastic empty barrels, paper waste, computer monitors, firewood.

These two types of solid wastes are produced at ARL and are well- managed also.

7. Solid Waste Disposal

7.1. Disposal of solid waste at ARL

Hazardous Waste Management is a vital environmental problem, which requires explicit attention by all concerned. Disposal activities performed by ARL are Bio-remediation, incineration and composting. The sources of the sludge at ARL are crude storage tanks, furnace oil storage tanks, product storage tanks, API separators, C- sump and oily pits which are properly disposed off by bioremediation & incineration, depending upon the total petroleum hydrocarbon (TPH) value. If TPH value is less than 50%, then bioremediation is the way to dispose off waste otherwise incineration will be the other feasible option. All disposal activities are carried in an environmental friendly manner.

Disposal of waste at ARL is done in the following ways.

7.2 Bioremediation

Bioremediation is the process of using living microorganisms to clean up a contaminated site. The main objective of bioremediation is to treat the oily sludge, to protect the local environment from the impact of oily sludge, to minimize the risk of fire and to restore the impacted site.

Both aerobic and anaerobic methods are used for the treatment of the contaminated oily sludge. Bioremediation of oily spills and sludge is being done at ARL through the aerobic and anaerobic bioremediation method.

Aerobic bioremediation of the sludge is carried out when TPH value is less than 10% otherwise anaerobic bioremediation is used for the treatment of oily sludge. Microorganisms decompose the hydrocarbons by using enzymes capable of degrading petroleum and are useful in cleaning up oil sludge.

In anaerobic bioremediation, the degradation of organic waste is done in the absence of oxygen. In ARL, for bioremediation Cleaner production microbes (CPM) technology is used which include following steps:

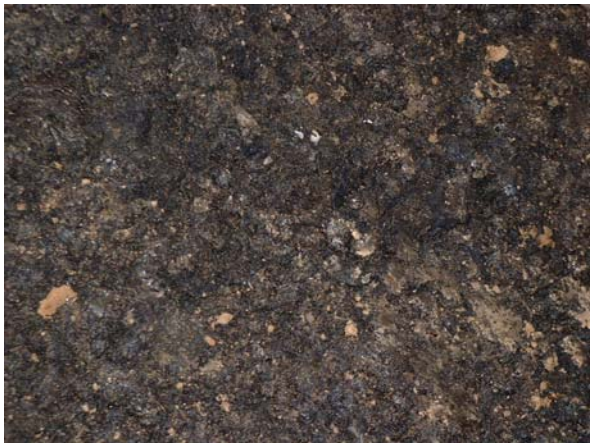
First, collect the sludge and mix it with cleaner production microbes. Select a suitable place and excavate a pit. The pit is lined with polythene sheets to avoid the leaching. Then, the mixing material (sludge and cleaner production microbes) is filled in the pit and cleaner production nutrients. Fill the 3 inches layer of fresh soil at the bottom of the pit. Then, layering of the mixture upto 3 inches is done and spread the nutrients according to the quantity of the mixture. Repeat the above steps unless the whole pit gets filled. Then, the pit is covered with the polythene sheet for complete

packaging in case of anaerobic bioremediation while in aerobic, no cover is used.

The degradation process had started soon after the completion activity and complete decomposition of hydrocarbons occurred 10 to 12 weeks.

Original Sludge (before treatment).

Sludge during bioremediation process.



Sludge after bioremediation process.

Oil Spillage Bioremediation.

Some advantages of the Bioremediation are:

- A natural process that destroys organic and inorganic contaminants
- Byproducts are generally innocuous
- Represent a closure solution
- Cost effective when compared to other technologies
- Can be performed on site (In-situ)

Uptil now, the Bio-remediation of the following wastes has been carried out at ARL:

1. Bowser spill ~~~~ 884 Metric Ton

2. Sludge from different refinery sources ~~~~ 180 Metric Ton

7.3. Incineration

The demands of present society create wastes that appear to increase in quantity as the standard of living increases. The ability of land, water and air to absorb these wastes is limited. Poisoned rivers, darkened skies and wastelands are endemic to the industrial world. Incineration is the complete combustion of waste at high temperatures.

It uses a wide variety of combustion and fluidized bed incinerators. Incineration can treat healthcare and industrial waste at the same time. It can be defined as:

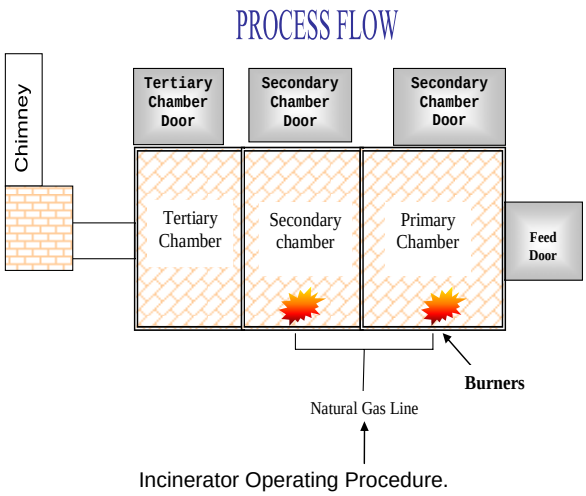
Incineration is a high temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and

results in significant reduction of waste volume (up to 95%) and weight (up to 75%).

This process is usually selected to treat wastes that cannot be recycled, reused or disposed off at a landfill site. The main benefit of incineration is that it breaks down some hazardous; non-metallic organic wastes and destroys bacteria and viruses. ARL is using the three chambered incinerator (specifications mentioned below) for the combustion of all types of wastes. After the incineration procedure, the ash is properly land filled in the pit which is internally lined with polythene sheet to avoid leaching. Annually ARL incinerator is treating 77 metric tons of waste.

Three Chambered Incinerator Specifications

- Capacity: 50 kg/hr
- No. of Chambers =Three
- Startup Temperature=Pre fired up to 600 ^{0} C
- Primary Chamber Temperature=850- 950 ^{0} C
- Secondary Chamber Temperature=950-1100^{0} C
- Flue Gas Retention Time = 3 seconds
- Fuel Used = Natural Gas



Incinerator Operating Procedure.

Incinerator at ARL.

7.4. Composting

Composting is decomposition of large molecules of organic material into small particles that plants can use easily and directly through the action of decomposing bacteria. It has two types aerobic and anaerobic. ARL has initiated composting of solid waste consisting of biodegradable organic materials in its area. The objective of composting is to manage organic waste, either kitchen or garden, in an environmentally friendly way and to produce a product (biofertilizer) that is nutritious enough to support plant growth, strengthen soil structure and recharge the soil up to its required hummus level. The organic waste includes leaves, twigs, branches, grass clippings, fruits, vegetables, and all edible material used in the kitchen. The organic material is converted into valuable compost through a number of ways. The most easy and efficient way is to dump all waste in a pit mix it with cow dung in equal quantity and maintain sufficient humidity as well as sufficient supply of fresh air. Aerobic composting is faster than anaerobic. The fertilizer produced through composting is being used in home gardens and at ARL vegetable farm. Vegetable farm is producing organic vegetables that are used at ARL dinner for employees. The compost is also available for sale.

8. Gaseous Waste

Gaseous emissions from industries vary with the type of fuel used and the process of manufacturing. The effect of the industrial emissions would not be confined to that particular atmosphere where these plants are installed but also to the surroundings and adjacent areas at large. The level of toxicity of different gases is different depending upon nature of gas and quantity of release. Emissions of toxic gases have

devastating effects on our environment from global warming to ozone depletion. CO_2 is the Major effective agent in causing global warming and CFCs (Chloro Flouro Carbons) against ozone depletion. ARL decided as a policy matter to discontinue purchase of all such equipments that used ozone depleting substances. In implementation of the same, the major equipments that were changed included air conditioners and refrigerators. The already installed equipments that use CFCs are being gradually replaced. Similarly on the other hand, a number of initiatives have been taken to reduce inventory of Green House Gas. So far implemented projects have resulted in saving of 20,358 Tons per year of CO_2.

For tolerable limits of emissions, ARL has taken effective measures to maintain their emission levels in compliance with the NEQS and thus ensuring cleaner production, leading safe and healthy environment. But still there are some other emissions which are not complying NEQS and needs mitigative measures. Amongst them are the emissions (H_2S, NOx) from Power Plant 2 and 3 and are reported to the federal EPA. (Tables 3 and 4).

Table 3. NEQS limit when the plant is operating at gas.

Parameters	Unit	Neqs Limit	Effluent at ARL
Particulate Matter	mg/Nm^3	300	79
Smoke	Ringlemann Scale	1.5	2
CO_x	mg/Nm^3	800	1 - 102
NO_x	mg/Nm^3	400	0 - 325
SO_X	mg/Nm^3	1700	0 - 1419
H_2S	mg/Nm^3	10	0 - 26

Table 4. NEQS limit when the plant is operating at oil.

Parameters	Unit	Neqs Limit	Effluent at ARL
CO_x	mg/Nm^3	800	63 - 331
NO_x	mg/Nm^3	600	220 - 1314
SO_X	mg/Nm^3	1700	0 - 395
H_2S	mg/Nm^3	10	0 - 31

9. Conclusions

Waste is generated as a result of all industrial activities. Even if we assure zero production, even then we cannot ensure zero pollution. To manage waste of all kinds, industries themselves have to take promising steps for the waste minimization and management. ARL is excellent in the sense that it has taken significant steps in establishing cleaner and safer environment by properly handling all the three aspects of waste management i.e. waste minimization, recycling, reuse and disposal. The interventions regarding industrial waste management are in full practice at ARL to meet the National Environmental Quality Standards (NEQS). Moreover, waste management is not only the observance to government policies but compliance to our corporate social responsibility (CRS). In a way, it is great contribution towards individual as well as national economies through a two way process, use of minimum resources, a point of conservation, and reuse them instead to dig new resources and cause depletion at large. It is worth mentioning to show waste management financial aspects also because ARL raises slogan of turn waste into profit. The recovered furnace fuel oil cost is too much high in one year, recycled water paid in millions and similarly sale of scrap material is another source.

References

[1] Sustainability Report 2007, Attock Oil Refinery Limited, Rawalpindi.