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Thermo-economic Analysis of a Small Scale Retrofit Municipal Solid Waste Fueled Power Plant

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***Abstract*—This paper evaluates the thermo-economics of a small scale retrofit municipal solid waste (MSW)-fuelled power plant proposed to be sited in Port Harcourt, Rivers State, Nigeria. The design parameters for the combustor which utilizes mass combustion in stoker crate furnace is operated at steam saturation pressure of 38.2bar, with fuel consumption rate of 41.3tonne/hr (11.88kg/s) and was selected for the amount of MSW generated in Port Harcourt metropolis. The data used in assessing the availability of the fuel (MSW) were obtained from waste dumpsites controlled by Rivers State Waste Management Agency (RIWAMA). MATLAB Software modelling was used for the thermodynamic analysis to appropriately retrofit a steam turbine power cycle to the selected combustor and the result shows that the optimal performance of the proposed MSW plant gives a net power output of 5.23MW. The result further shows that heat energy in the steam entering the turbine is equivalent to 0.71MWh per tonne of waste. Therefore, at 17.3% thermal efficiency of the proposed MSW plant, 0.13 MWh of electricity will be produced per tonne of waste combusted. However, it is estimated that the plant may consume 15% of the electricity, which implies that 0.11MWh/tonne will be exported to the grid. Thus, as the plant is expected to process 340770.3tonnes/yr of MSW, the net electricity output of the proposed plant is estimated at 37.48GWh per year. The economic evaluations have shown that the Net present worth of the plant is $6395107.07 with a payback period of 7years for a 20years life cycle. This work thus indicates huge potentials in generating electrical power and wealth from MSW in Port Harcourt and environs with the use of cheap and readily available fuel from municipal solid waste. It also reveals a viable and economical means of waste management in the city.**

***Index Terms*—Municipal-Waste; Net-Present-Value; Steam-Flow; Thermal-Efficiency; Waste-to-Energy.**

I. Introduction

The production of municipal solid waste is growing at an ever-increasing rate and its accumulation is becoming a major problem. Consequently, more sustainable and acceptable waste management scheme is vital for every society. Nowadays, due to environmental, financial and social requirements, a more rational waste management is considered necessary. The willingness to minimize the accumulated waste along with the increased energy demand has led to the development of the third-generation waste management systems. Such systems are the waste-to-energy (WTE) facilities which are considered friendly for both the environment and the society [1].

According to the work of [2] about 2.26MW of electrical energy could be generated daily from wastes per city in Nigeria. This is quite significant in the quest for alternative/complimentary energy source in Nigeria. To minimize waste management difficulties, the use of fuels like MSW is necessary. This may also provide another means of guaranteeing a sustainable energy supply [3]. The CO_2 impact of MSW is close to that of biomass because MSW as a renewable energy source consists much of plant-based materials. MSW management can be enhanced by employing waste-to-energy (WTE) facilities. Reduction in greenhouse gas emissions can be achieved by encouraging biomass-based energy generation technology which would minimize open dumping of waste [4].

Efforts have been made by researchers to develop techniques to manage municipal solid waste in Nigeria and other developing countries with a view to reducing health hazards associated with poor management of solid wastes. One of the ways to manage MSW is its conversion to energy in the form of heat and electricity [5].

It has been found by [6] that municipal solid waste (MSW) generated in Port Harcourt are in very large quantities, but are mainly littered all over the city. Besides, they observed that refuse are mostly buried underground while some are recklessly burnt openly which constitute environmental hazards. Their empirical analysis showed that waste gathered from various dumpsites and receptacles in the city of Port Harcourt consisted of 66.6% volatile solids, 13.5% fixed solids, 19.1% liquid and 0.8% other compositions. Average biodegradability fraction was found to be 0.807, with a carbon-to-nitrogen ratio of 27:1, and the energy content of the solid waste was calculated as 7.25 MJ/kg. They suggested that other options of refuse disposal could be used to reduce adverse impact on the environment.

Waste incineration is a process carried out with surplus of air and releases energy, producing solid residues as well as flue gas that is emitted into the atmosphere [7]. As a result of emission and safety concerns, there is a certain temperature range that is demanded for this type of process. In the case of mixed waste, a furnace temperature of 1050°C is required. A generic description of an incineration process shows that waste is first deposited and processed on a moving grate in order to achieve correct combustion. Before undergoing the combustion phase, the incoming waste could be exposed to pre-treatment, depending on its quality, composition and the selected incineration system [8].

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It has been opined that high efficient electrical power generation system could be developed of WTE facilities by employing more advanced, high corrosion and stress resistant steels for boiler materials or coat boiler tubes with corrosion-resistant plating [9]. It was suggested that an alternative way could be to modify the entire WTE process. Many researchers are currently investigating this alternative way. Some WTE technologies have gained little success and therefore more researches and development are still required to be done in order to obtain a more reliable and highly efficient technology.

Different technologies have been deployed to obtain energy from MSW around the globe depending on the conditions of the waste in different regions. Nigeria as a developing nation is faced with power generation issues, particularly generation from non – conventional sources like renewable municipal solid waste. This research work thus presents a method of generation of electric power from MSW generated and collected in Port Harcourt using combustion pathway, retrofit technology. The paper further investigates the viability of using such technology. The main aim of this paper, therefore, is to conduct thermo-economic analysis of a proposed small scale retrofit municipal solid waste fueled power plant in Port Harcourt, Nigeria, as a way of harnessing the energy in municipal solid waste (MSW) for electricity generation in Port Harcourt. This would serve as an option to supplement power generation from conventional sources.

In doing so, the conditions of renewable municipal solid waste (MSW) generated in Port Harcourt were investigated; the minimum quantity of electrical power that can be generated from renewable MSW on daily basis was properly evaluated using appropriate thermodynamic and mathematical tools; and the economic viability of generation of electric power from MSW disposed and collected in Port Harcourt was technically evaluated.

II. Methods

A. Description of the Proposed MSW-fuelled Steam Power Plant

The power plant is designed to generate electric energy through direct combustion of Municipal Solid Waste. The plant (schematic diagram shown in Fig. 1) consists of the Combustor that is physically separated from the Boiler, Boiler with natural circulation of liquid water and steam in the Economizer, Evaporator and Superheater respectively, Steam Turbine, a single stage unit, Condenser, and Feed Pump.

The flue gas with enough heat energy exiting the combustion chamber is channelled to the boiler to produce high pressure steam by heating saturated water flowing into it from the pump. The flue gas during the process loses heat to the boiler and it goes through a cleaning system before it is being released to the atmosphere via the stack.

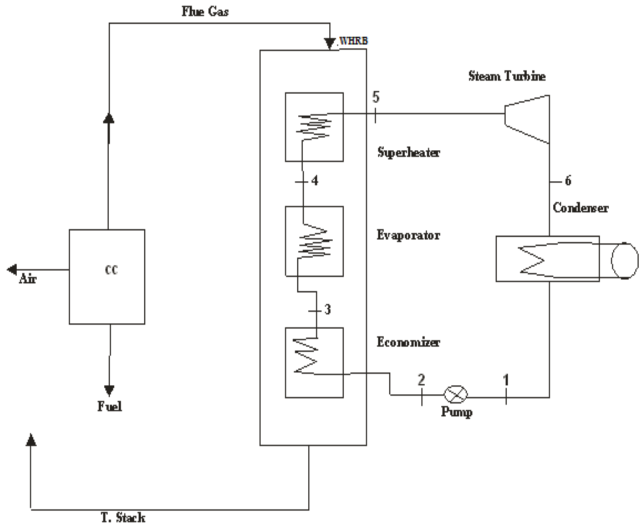

Fig. 1. Schematic Diagram of the Proposed Municipal Solid Waste-Fueled Power Plant

The steam power cycle principle is used for the thermodynamic analysis of the power plant. High pressure superheated steam produced in the boiler, at state 5 enters the single stage steam turbine where it is expanded to low pressure steam at state 6 thereby producing shaft power. The low-pressure steam is condensed in the condenser to saturated liquid water at state 1. The resulting saturated liquid water is returned to the boiler by the feed pump and the cyclic process repeats. The steam turbine power cycle on a T-S diagram is as shown in Fig. 2.

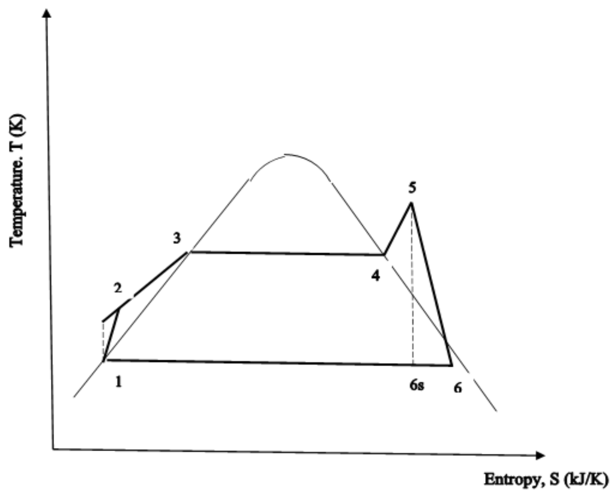

Fig. 2. T-S diagram of the steam turbine power cycle to be retrofitted

B. Resources (Fuel) Availability Assessment and Thermo-Economic Models

To ascertain the availability of the fuel, the mass flow of MSW is estimated for three dumpsites operated by the wastes management agency. The physical and chemical compositions of the MSW were also investigated to determine its suitability for energy conversion.

In the combustion chamber, MSW and air are burnt completely to produce high temperature flue gas that is used to heat the fluid flowing through the boiler.

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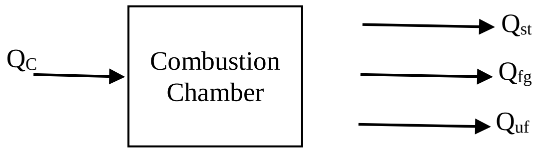

Fig. 3. Heat balance in the combustion chamber

Heat balance in the combustion chamber, Fig. 3 taken as a control volume is given by [4] as in (1)

$$Q_C = Q_{st} + Q_{fg} + Q_{uf} \quad (1)$$

Where Q_c is the heat liberated in the combustion chamber, Q_{st} is the heat gained by steam in the boiler, Q_{fg} is the heat loss by flue gas at stack exhaust and Q_{uf} is the heat lost due to unburnt fuel.

$$Q_c = \dot{m}_f \, CV_f \quad (2)$$

where $\dot{m}_f$ is the mass flow of fuel (MSW) and CV_f is the calorific value of the fuel.

$$Q_{st} = \dot{m}_{fg} \, C_{Pfg} (T_c - T_s) \quad (3)$$

where $\dot{m}_{fg}$ is the mass flow of the flue gas, C_{Pfg} is the specific heat capacity of the flue gas, T_C is the combustion chamber temperature and T_s is the stack temperature.

$$m_{fg} = m_f + m_a \quad (4)$$

$$C_{Pfg}(T) = 0.991615 - [\frac{6.99703T}{10^5}] + [\frac{2.7129T^2}{10^7}] - [\frac{1.22442T^3}{10^{10}}] \quad (5)$$

$$Q_{uf} = \dot{m}_{uf} \, CV_f \quad (6)$$

where m_{uf} is mass of unburnt fuel.

Applying the heat balance equations of the combustion chamber in conjunction with the schematic diagram of the steam cycle of the power plant (Fig. 1) gives:

$$Q_{st} = \dot{m}_s (h_5 - h_{2s}) = \dot{m}_{fg} \, C_{Pfg} (T_c - T_s) \quad (7)$$

and

$$\dot{m}_s = \dot{m}_{fg} \, C_{Pfg} (\frac{T_C - T_s}{h_5 - h_{2s}}) \quad (8)$$

Where m_s is the mass flow rate of the steam produced in the boiler, h_5 and h_{2s} are the specific enthalpies of the steam at the boiler exit and inlet respectively.

The heat added in each component of the heat recovery boiler are given by [9] as follows:

The Super heater:

$$Q_{SH} = \dot{m}_s (h_5 - h_4) \quad (9)$$

The Evaporator:

$$Q_{EV} = \dot{m}_s (h_4 - h_3) \quad (10)$$

The Economizer:

$$Q_{EC} = \dot{m}_s (h_3 - h_{2s}) \quad (11)$$

Total heat added in the Boiler is given by the relation,

$$Q_B = Q_{EC} + Q_{EV} + Q_{SH} \quad (12)$$

The boiler efficiency is calculated using the relation,

$$\eta_B = \frac{Heat\,supplied}{Fuel\,energy} = \frac{\dot{m}(h_5 - h_{2s})}{\dot{m}_f \, CV_f} \times 100 \quad (13)$$

The actual power output of the steam turbine is determined using the isentropic efficiency as shown in (14).

$$\eta_{isen} = \frac{P_{ST}(actual)}{P_{ST}(isentropic)} = \frac{\dot{m}_s (h_5 - h_6)}{\dot{m}_s (h_5 - h_{6s})} \quad (14)$$

that is,

$$P_{ST}(actual) = \eta_{isen} \times \dot{m}_s (h_5 - h_{6s}) \quad (15)$$

and

$$h_6 = h_{f6} + x_6 h_{fg6} \quad (16)$$

where P_{ST} is the power developed at the steam turbine generator terminal, η_{isen} is the isentropic efficiency of the steam turbine and h_6 is the specific enthalpy of steam at turbine exit x_6 is the dryness fraction of the steam exiting the turbine. Considering an isentropic process, the heat rejected in the condenser is presented as:

$$Q_{CD} = \dot{m}_s (h_{6s} - h_1) \quad (17)$$

The pump power input is given by the relation,

$$P_P = \dot{m}_s (h_{2s} - h_1) \quad (18)$$

The net power output of the power plant is given by,

$$P_{NET} = P_{ST} - P_P \quad (19)$$

The steam turbine cycle thermal efficiency is given by,

$$\eta_{ST} = \frac{P_{NET}}{Q_B} \quad (20)$$

The Net Present Value (NPV) is used to assess the future series of after-tax cash flow (ATCF) realised for the power generation and utilization. The NPV of the financial benefits is compared with the NPV of the investment to determine whether the investment has a positive return. Mathematically the NPV as expressed by [10] is given as stated in (21).

$$NPV = -F_o + \sum_{t=1}^{N} \frac{F_t}{(1+d_t)^t} \quad (21)$$

Where:

d_t is the market discount rate during the period t in years, and when it is considered constant $d_t = d$

N is the period in time in years for which the plant is assumed to operate

F_t is the net cash flow in years t

F_0 is the present worth of the investment (at time t = 0)

The internal rate of return (IRR) is the discounted rate that results in an NPV value of zero. This means that the IRR is the discount rate that makes the net present worth of the future cash flow equal the plant capital investment cost. It is evaluated using iteration techniques. That is,

$$F_0 = \sum_{t=1}^{N} \frac{F_t}{(1+IRR)^t} \quad (22)$$

Where

IRR is the internal rate of return

N, F_t, and F_0 are as defined in (21).

The simple-payback-period (SPBP) is the length of time usually in years taken to recover the initial cost of investment of the MSW power plant based on the annual savings realised. That is,

$$SPBP(years) = \frac{Capital\ investment\ cost\ of\ MSW\ plant}{Annual\ saving\ from\ the\ Energy\ Generated\ by\ the\ plant} \quad (23)$$

Some unit cost elements and assumptions used in the economic analysis are shown in Table I including their source references.

TABLE I: COST CONSIDERATIONS AND ASSUMPTIONS

Parameter	Values	References
Boiler capital cost	104.98($/kW)	[11][10]
Boiler operation & maintenance cost	0.0052($/kWh)	[11]
MSW plant capital cost ≤ 10MW	1531($/kW)	[12]
MSW plant operation & maintenance cost	342.82($/kWh)	[12]
Cost of Energy (Nigeria)	30.23(₦/kWh) (0.083$/kWh)	[13]
Cost of MSW collection	0.022($/tonne/yr)	[14]
Plant Availability	91% (8000hrs)	[10]
Discount rate (d), Electricity tariffs escalation rate, MSW collection escalation rate, O&M escalation rate and Plant life cycle (N)	10%, 5%, 1%, 3% and 20years respectively	[10][15]

III. RESULTS AND DISCUSSION

A. MSW Power Plant Design and Performance Analysis

The result shows that 41.3 tonne/hr is generated and there is a need to get a combustor that can burn the amount of waste indicated. The design data of the MSW combustor chosen for the retrofitting is shown in Table II. The data is used as the basis to carry out a retrofitting iteration calculation to know the actual capacity of the MSW boiler and the steam turbine plant needed for power generation. Eight iterations (cases) at different steam saturation pressure and stack temperature were evaluated and result shown in Table III.

TABLE II DESIGN DATA FOR MSW COMBUSTOR (ZG-45/3.82-T) [16].

Parameter	Values
Capacity	45tonnes/hr (12.5kg/s)
Saturation Pressure	38.2 bar
Steam Temperature	400°C
Feed Water Temperature	105°C
Mass of Air required/ Kilogram of MSW	283tonne/hr (78.7kg/s)
Mass of flue gas	314tonne/hr (87.1 kg/s)
Calorific Value of the MSW	15632 kJ/kg

B. Retrofit Steam Turbine Power Plant Analysis

. To utilize the energy from the flue gas in the chosen combustor to burn 41.3 tonnes/hr of MSW, a steam turbine retrofitting design is required to actually know the capacity. To achieve this, eight different iterations were carried at chosen saturation pressure and stack temperature as shown in Table III.

TABLE III: RESULT OF THE THERMODYNAMIC ANALYSIS OF THE RETROFITTED MSW-FUELLED POWER PLANT

Cases	P_5 [bar]	T_s [°C]	m_s [kg/s]	Q_B [MW]	P_{ST} [MW]	W_P [MW]	P_{net} [MW]	$\eta_{MSWplant}$ [%]
1	20	170	9.8482	30.1642	5.4752	2.0886	3.3866	11.2
2	20	180	9.8482	29.2502	5.4752	3.0027	2.4725	8.5
3	30	170	9.4917	30.1634	5.5245	0.8166	4.7079	15.6
4	30	180	9.4917	29.2503	5.5245	1.7306	3.3939	13.0
5	35	170	9.3463	30.1634	5.5215	0.2917	5.2308	17.3
6	35	180	9.3463	29.2502	5.5215	1.2047	4.3168	15.0
7	40	170	9.2143	30.1641	5.5239	-1.7508	7.2747	24.0
8	40	180	9.2143	29.2501	5.5239	0.7240	4.999	16.4

The result from the analysis shows that the heat in the steam entering the turbine is equivalent to 0.71MWh per tonne of waste. At a steam temperature 400°C and pressure of 35bar, the thermal efficiency of the plant is evaluated at 17.3% as shown in case 5. Therefore 0.13 MWh of electricity will be produced per tonne of waste combusted. However, it is estimated that the plant may consume 15% of the electricity, which implies that 0.11MWh/tonne will be exported to the grid. Therefore, if the plant is expected to process 340770.3tonnes/yr, the net electricity output of the proposed plant is estimated at 37.48GWh.

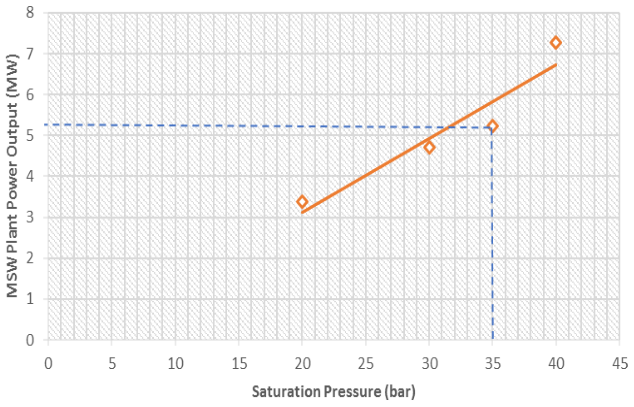

Fig. 4. Variation of MSW Plant Net Power Output with Saturation Pressure

From the analysis, the result show that for cases 1, 3 and 5 as the saturation pressure increase at constant stack temperature, the MSW net power generated increases. This trend is evident in the graph of Fig. 4. Similarly, for cases 2, 4 and 6, the trend increases likewise. The result further shows that for every 1% increase in the saturation pressure, the MSW net power output increase by 0.37% at 170ºC stack temperature, while for 1% increase in the saturation pressure at the stack temperature of 180ºC, the MSW plant net power output increases by 0.38%. Although in case 7, we have higher value but a constraint is observed because of the negative pump work, which created an impossible scenario. Therefore, the optimal design point based on the choice of the MSW combustor is case 5 as indicated with 5.23MW power output.

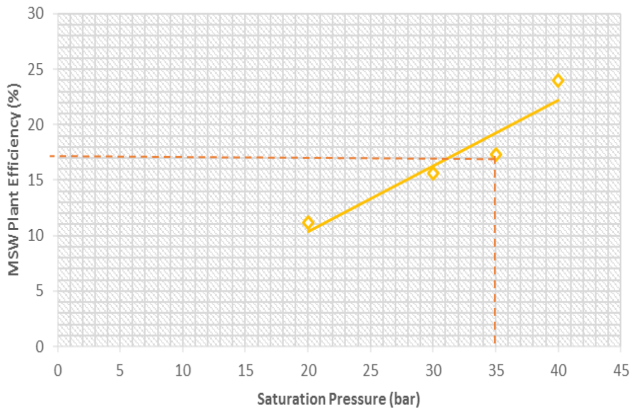

Fig. 5. Variation of MSW Plant Efficiency with Saturation Pressure

Fig. 5 revealed that for the stack temperatures of 170ºC and 180ºC, the MSW plant thermal efficiency increases by 1.22% and 1.30% respectively for every 1% increase in the saturation pressure between cases 1-6.

Fig. 6. Variation of MSW Plant Pump Work with Saturation Pressure

Fig. 6 show the design values of the pump required for the plant under various considerations. The result show that the pump drops consistently as the steam pressure increases at the two stack temperatures. For case 5, from the point of optimal design analysis, we have the minimum pump work.

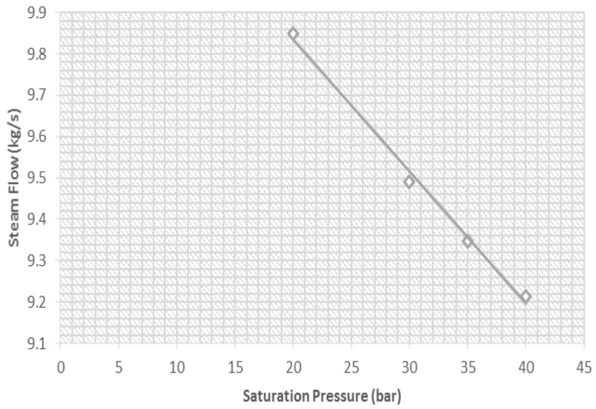

Fig. 7. Variation of Steam Flow with Saturation Pressure

Fig. 7 shows the trend of the steam generated with variation in the saturation pressure. It reveals that for every 1% increase in the saturation pressures the steam flow increases by 0.1% at 170ºC and 180ºC stack temperatures. This implies that the stack temperature effect on the steam flow is negligible.

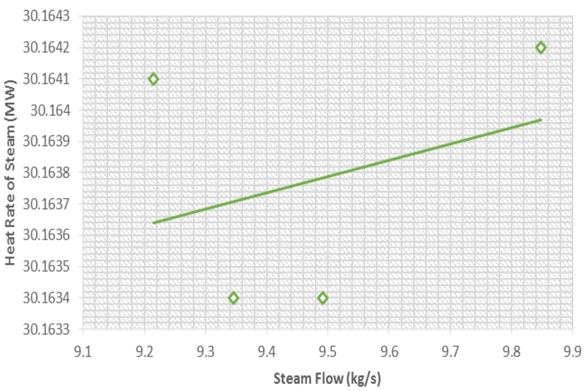

Fig. 8. Variation of Heat Rate of Steam Generated with Steam Flow

Fig. 8 shows that the increase in the steam flow increases the heat rate of the steam entering the turbine. This implies that there is a direct proportional relation. This also gives us a guide on the choice of boiler needed for steam generation of the prevailing tonne of MSW available.

C. Results of the Economic Analysis of the Retrofit MSW Plant

The proposed plant at the preliminary design stage of 5.23MW was analysed using the highlighted economic tools to test its viability. The analysis was done using the various considerations as shown in Table IV

TABLE IV: PERFORMANCE ANALYSIS OF THE RETROFITTED MSW POWER PLANT

Month of Operation	Net Electrical Power Generated (Avrg) (MW)	Hour of Plant Operation (hr)	MSW Plant Available Energy (kWhe)	MSW Plant Energy Outages (kWh)	MSW Plant Revenue ($/kWhe)	Cost of Outages $/kwhe
January	4.45	663	2950350	517140	244879.05	42922.62
February	4.45	678	3017100	528840	250419.30	43893.72
March	4.45	690	3070500	538200	254851.50	44670.60
April	4.45	700	3115000	546000	258545.00	45318.01
May	4.45	586	2607700	457080	216439.11	37937.64
June	4.45	698	3106100	544440	257806.32	45188.52
July	4.45	680	3026000	530400	251158.01	44023.21
August	4.45	695	3092750	542100	256698.25	44994.32
September	4.45	583	2594350	454740	215331.05	37743.42
October	4.45	667	2968150	520260	246356.45	43181.58
November	4.45	680	3026000	530400	251158.10	44023.22
December	4.45	680	3026000	530400	251158.01	44023.21
		8000	**35600000**	**6240000**	**2954800.11**	**517920.02**

$$\text{The cost of MSW collected as fuel}\left(\frac{tonnes}{yr}\right) = \text{Waste generated (tonnes)} \times \text{Percentage of waste collected} \times \text{cost of waste collected}\left(\frac{\$}{tonnes}\right) = \$0.022\left(\frac{tonnes}{yr}\right) \times 329480 = \$7256.4$$

The simple payback period (SPBP) calculated is 6.1years (approximately 7years) given that the capital investment cost of WSM plant is $ 8,007,130.9.

The result of the predicted performance analysis of the plant design is shown in Table IV. The analysis was based on the net electricity generated of 4.45MW which represent 14.9% deviation from design. This was to account for possible losses for the period of operation. Using the availability of 91%, the operating hours were distributed according to the period under consideration.

The NPV technique was employed to predict the viability of the proposed 5.23MW plant for energy generation. That is,

$$\text{Initial cash flow } F_0 = (1 \times 5.23MW) \times \text{capital cost of MSW plant} \left(\frac{\$}{kW}\right) = (1 \times 5.23MW) \times 1531\$/kW = \$8007130$$

$$\text{The annual plant operation \& maintenance cost} = \text{plant capacity}(kW) \times \text{O\&M cost per kW} = 5230\,(kW) \times \frac{\$342.82}{kW\,yr} = \$1792948.62$$

TABLE V: NPV ECONOMIC ANALYSIS OF THE RETROFITTED MSW PLANT VIABILITY

End of year	MSW Plant O&M Cost (3% escalation rate) ($)	MSW Collection Cost (3% escalation) ($)	MSW Annual Electricity Revenue ($) (4% escalation due to tariff)	MSW Plant Annual net cash flow Ft ($)	Present value (10% discount rate) ($) Ft/(1+d)
1	1792948.62	7256.48	2954800	1154594.9	1049631.727
2	1846737.079	7329.0448	3072992	1218925.877	1007376.758
3	1902139.191	7548.916144	3195911.68	1286223.573	967085.3932
4	1959203.367	7775.383628	3323748.147	1356769.397	929294.1075
5	2017979.468	8008.645137	3456698.073	1430709.96	888639.7269
6	2078518.852	8248.904491	3594965.996	1508198.24	852089.401
7	2140874.417	8496.371626	3738764.636	1589393.847	815073.7677
8	2205100.65	8751.262775	3888315.221	1674463.309	782459.4901
9	2271253.669	9013.800658	4043847.83	1763580.36	747279.8136
10	2339391.279	9284.214678	4205601.743	1856926.249	716959.9418
11	2409573.018	9562.741118	4373825.813	1954690.054	685856.1594
12	2481860.208	9849.623352	4548778.846	2057069.014	655117.5204
13	2556316.015	10145.11205	4730729.999	2164268.873	627324.311
14	2633005.495	10449.46541	4919959.199	2276504.239	600660.7491
15	2711995.66	10762.94938	5116757.567	2393998.958	572727.0235
16	2793355.53	11085.83786	5321427.87	2516986.503	548363.0725
17	2877156.195	11418.41299	5534284.985	2645710.376	522867.6633
18	2963470.881	11760.96538	5755656.384	2780424.538	500076.3557
19	3052375.008	12113.79434	5985882.64	2921393.838	477351.9342
20	3143946.258	12477.20817	6225317.945	3068894.479	456002.1514
	48177200.86	**191339.134**	**87988266.58**	**3961972658**	**14402237.07**

The result of the analysis as shown in Table V, gave an estimated annual running cost of the MSW plant, the present value of the annual running cost of the plant and the present value of the first-year annual cash flow of the plant is $1,800,205.08, $1,049,631.73 and $1,154,594.91 respectively.

The result further shows that the initial cost of investment for the plant is $8,007,130. The plant O&M cost and the MSW collection cost for the first year of operation represent 23.4% and 0.09% respectively, with an annual cash flow of $1,154,594.91. This represents about 14.4% of the initial cost of investment. The present values of the annual running cost at the end of the first year of power generation represent

13.1% of the cost of investment. The result further shows that for every 1% increase in the cost of the plant operation based on the escalation consideration, the cash flow increases by 1.4%. This represents a positive trend for investment.

The net present value of the plant for the predicted operating period of twenty (20) years gave the worth of \$6,395,107.07, which represent 79.9% of the initial cost of investment in the MSW power plant. This is a positive trend which also proves that the waste-to-energy investment is viable. The payback period for the investment which is the ratio of the initial cash flow to the conventional annual running cost is about 7years for the 20years period of operation. This shows a good payback-period for the investment and it is an indication that the MSW plant is viable and has medium and long-term profit maximization.

IV. Conclusion

The Thermo-economic analysis of municipal solid waste fueled power plant has been done with the operational conditions taken into account. The findings of this research shows that energy in form of electricity can be produced from municipal solid wastes using appropriate design parameters and conditions. With a feedstock (fuel) of 340770.3 tonne/yr (11.88kg/s) of MSW for plant running 8000hours annually, about 9.3463kg/s of steam can be produced. This flow rate of steam at a turbine inlet temperature of 400℃ and saturation pressure of 35bar can be used to drive a turbine to produce a net power of 5.2308MW of which about 2.64MW could be exported to the grid after auxiliary consumption of part of the generated power at the power station every hour. This result compares favorably with the results of other works in the literatures reviewed in this work.

The economic analysis carried out indicates that the payback period is about 7years for the plant of 20years life cycle. This signifies that the proposed power plant is viable. More so, with attractive interest rate and lower inflation rate, a better scenario could be achieved.

It should be noted that the production of municipal solid waste is constantly on the increase as a result of the rapid population growth, rural-urban migration, the ever-accelerating urbanization and the continued improvement of standard of living of residence cities. Therefore, means such as utilization of MSW as a WTE technology should be implemented in order to provide avenue for economic disposal of waste as well as increasing power generation in cities such as Port Harcourt and its environs.

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