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# Air Pollution Control and Water Heater by using Paraffin Wax from Municipal Waste

**D. Bala Subramanian**

Assistant Professor, Mookambigai College of Engineering, Pudukottai, Tamil Nadu

*Abstract*— ***The main aim of the project is to heat the water by burning the waste obtained from the houses and other places. The flue gases can be obtained by burning the wastes inside the furnace and then these flue gases can be treated with the help of the catalytic converter to remove the harmful gases such as CO ,Nox , Sox . The treated flue gases will used to heat the phase change materials (i.e,) wax ,then the heat obtained from the wax can be used to heat the water will be used during the night time. The municipal waste Can be fed into the furnace at the top and free burning causes the fumes to heat the wax at 45˚C. (i.e,) the melting point of wax will in turn heat the water placed at the top by natural convection.***

***Keywords – Municipal waste, Paraffin wax, Catalytic converter, Heat transfer, Pollution control, Water heater.***

## I. AIR POLLUTION DURING THE MUNICIPAL WASTE BURNING

Municipal solid waste (MSW) remains a major problem in modern societies, even though the significant efforts to prevent, reduce, reuse and recycle. At present, municipal solid waste incineration (MSWI) in waste-to-energy (WtE) plants is one of the main management options in most of the developed countries. The technology for recovering energy from MSW has evolved over the years and now sophisticated air pollution control (APC) equipment insures that emissions comply with the stringent limits established in developed countries. This chapter shows the role of incineration in WtE processes in the ambit of MSW management, giving an overview of the MSWI technologies and APC devices used for cleaning the gaseous emissions. The main focus is on the key air pollutants, such as dioxins and furans. At the end, the impact of emission on health risks is also briefly considered.

### A. *PARAFFIN WAX:*

1) Paraffin wax is a white colorless soft solid derivable from petroleum, coal or oil shale that consists of a mixture of hydrocarbon molecules containing between twenty and forty carbon atoms.

2) It is solid at room temperature and begins to melt above approximately 37˚c, its boiling point is greater than 370˚c.

3) Common application for paraffin wax include lubrication , electrical , insulation and candles. It is distinct from kerosene another petroleum product that is sometimes called paraffin

4) paraffin wax is used synonymously in chemistry with alkane , indicating hydrocarbons with the general formula latin, parum or lackin reactivity, referring to paraffins unreactive nature.

### B. *PROPERTIES*

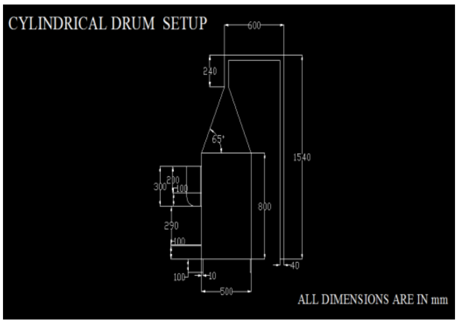
- It is slag wax
- It is white, odorless ,tasteless waxy solid
- Melting point 46 to 68˚C
- 

### C. *MANUFACTURING*

The feed stock for paraffin wax is slag wax, which is a mixture of oil and wax ,byproduct from the refining of lubricating oil. The first step in making paraffin wax is to remove the oil from the slag wax. The oil is separated through crystalisation. Most commonly the slag wax is heated, mixed with one or more solvents such as ketone and then cooled. As it is cooled wax

### D. *WORKING PRINCIPLE:*

The main aim of this experimental setup is to control the air pollution and also produce the water heater from the municipal waste.




The primary stage collects the wastage from the municipal area. And then pass the wastage into the hopper. And it transferred to the drum setup, the bottom of the drum setup contains a small hole for heating purpose to burn the waste materials. N this same hole compressed air is passing for to pick up the burning process.

After a few seconds the waste material gets burned and release the fumes which contains unwanted impurities. To remove the unwanted impurities by using catalytic converter. It place a important function of this setup. It will convert the fumes in a good condition. And then the fumes flow through the pipeline and then the fumes entered into bottom of the water heater setup. In the zone there is three layers contains, upper part of the zone water is present ,the second layer filled with paraffin wax, third layer contains fumes. The fumes heated the paraffin wax, and then the paraffins wax gets melted at 45˚c.Then the heat is transferred into water, and then the water gets heated. Finally the exhaust heat and gas were passed through the outlet port and it combines with the atmosphere.

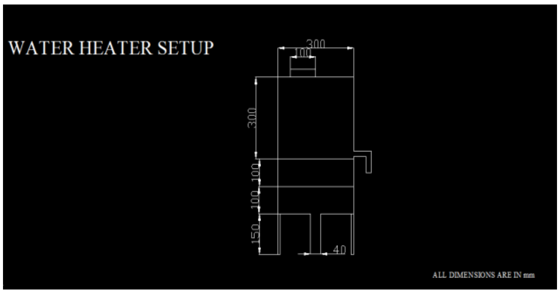
### *E. DESIGN CALCULATION*
### *CYLINDRICAL DRUM*

Diameter =500mm=0.5m
Height =800mm=0.8m
Volume $=\pi r^2 h$
$=3.14\times(0.250)^2\times0.8$
V $=0.157m^3$

### *F. FRUSTUM OF CONE:*

Diameter d1= 500mm=0.5
d2= 40mm=0.04m
Height h= 500mm=0.5m
volume v= h/3(d1+d2+(d1d2)0.5)
=0.5/3(0.5+0.04+(0.5×0.04)0.5)
V =0.113m3

### *G. WATER HEATER SETUP:*




Diameter =300mm
Height =500mm
Volume =Πr2h
=3.14×(.15)2×0.5
=0.035m3
Wax filled volume = Πr2h
=3.14×(.15)2×0.1
v =0.0076m3

### H. *TABULATION*

Municipal waste weight=10kg
Burning time period =2hrs
Paraffin wax level =4kg

| Season | FN | FN | AN | AN | Night |
|---|---|---|---|---|---|
| Time | 09.00am | 12.00am | 03.00pm | 06.00pm | 09.00pm |
| Wax temperature(Tw)˚C | 60 | 60 | 59 | 55 | 50 |
| Water normal temperature(Tn)˚C | 27 | 35 | 36 | 26 | 25 |
| Water heated temperature(Th)˚C | 35 | 40 | 42 | 38 | 35 |
| Heat transfer Q(W)×104 | 47.09 | 52.39 | 48.82 | 45.18 | 41.84 |

### I. *CALCULAIAON*

**Case(1):**

Wax melting temperature (Tw)=60˚C
Water normal temperature(Tn) =27˚C
Water heated temperature(Th) =35˚C

Film temperature (Tf) =( Tw+Tn)/2
= (60+27 )/2
Tf = 43.5˚C
Tf = 316.5

Properties of water in saturated state: (HMT data book ,page no:22)
Density (ρ) = 995 kg/m3
Kinematic viscosity (υ) = 0.657×10-6 m2/s Prandtl number (Pr) = 4.34
Thermal conductivity(k) = 0.628 W/mk
Length of water heater(L)=0.3m
Temperaturdifference(ΔT)=60-35=25˚C=298K β=1/Tf =1/316.5= 3.159×10-3
Grashaff number (Gr) =(βgΔTL3)/υ2
=(3.159×10-3×9.81×298×0.33)/(0.657×10-6)2
Gr = 5.889×1011

Gr.Pr =(5.889×1011×4.34)
Gr.Pr = 2.556×1012

### J. *Natural convection*

(Heat transfer book , page no:7.8)
Nu =0.13(Gr.Pr)1/3 when (109<Gr.Pr<1012)
=0.13(2.556×1012)1/3
Nu = 1777.4 W/mk

Let,
Nu = hL/k
1777.4 = (h×0.3)/(0.628)
h = 3720.8 W/m2k

Area of water heater(A) = 2Πr(h+r)
=2Π(0.3)(0.3+0.3)
A = 0.424 m2

Heat transfer ,Q1 = hAΔT
= 3720.8×0.424×298
Q1 = 47.09×104 W

Case(2):
TW =60˚C ; TN = 35˚C

$T_f = (60+35)/2$
$T_f = 47.5^\circ C$
$T_f = 320.5K$

Properties of water in saturated state:

$\rho = 990\ kg/m^3$
$\upsilon = 0.567\times10^{-6}\ m^2/s$
$Pr = 3.68$
$K = 0.639\ W/mk$
$\beta = 1/T_f = 3.12\times10^{-3}$
$\Delta T = 60-40 = 20^\circ C = 293K$
$L = 0.3m$

$Gr = (\beta g \Delta T L^3) / \upsilon^2$
$= (3.1\times10^{-3}\times9.81\times293\times0.3^3) / (0.567\times10^{-6})^2$
$Gr = 7.53\times10^{11}$
$Gr.Pr = 7.53\times10^{11}\times3.68$
$Gr.Pr = 2.77\times10^{12}$

Natural convection :
(Heat transfer book , page no: 7.8)

$Nu = 0.13(Gr.Pr)^{1/3}$
$= 0.13(2.77\times10^{12})^{1/3}$
$Nu = 1825.7\ W/mK$
$Nu = hL/k$
$1825.7 = (h\times0.3)/(0.639)$
$h = 4217.44\ W/m$

Heat transfer $,Q_2 = hA\Delta T$
$= 4217.44\times0.424\times293$
$Q_2 = 52.39\times10^4 W$

Case(3) :

$T_w = 59^\circ C$ ; $T_n = 36^\circ C$
$T_f = (59+36)/2 = 47.5^\circ C$
$T_f = 320.5K$

Properties of water in saturated state:

$\upsilon = 0.557\times10^{-6}\ m^2/s$
$Pr = 3.8$
$K = 0.638\ W/mK$
$\beta = 3.09\times10^{-3}$
$\Delta T = 290K$

$Gr = (3.09\times10^{-3}\times9.81\times290\times0.3^3)/(0.557\times10^{-6})^2$
$Gr = 7.65\times10^{11}$
$Gr.Pr = (7.65\times10^{11}\times3.8)$
$Gr.Pr = 2.908\times10^{12}$

Natural convection:
(Heat transfer book ,page no:7.8)

$Nu = 0.13(Gr.Pr)^{1/3}$
$= 0.13(2.908\times10^{12})^{1/3}$
$Nu = 1855.6\ W/mK$
$Nu = hL/k$
$1855.6 = (h\times0.3)/0.638$
$h = 3946.26\ W/m^2K$

Heat transfer $,Q_3 = hA\Delta T$
$= 3946.26\times0.424\times290$
$Q_3 = 48.82\times10^4\ W$

Case (4):

Tw =55˚c     Tf =26˚

Tf = (55+26)/2 = 40.5˚c

Tf = 313.5k

Properties of water in saturated state:

υ = 0.657 × 10-6m2//sec

Pr = 4.34

k = o.628W/mk

ΔT = 290K

β= 3.189x10-3

Gr = (9.81x3.189x10-3 x290x(0.3)3)/(0.657x10-6)2

Gr= 5.675x1011

Gr.Pr = 5.675x1011x4.34 = 2.46x 1012

Let,

Nu = 0.13x (2.46x1012)1/3

Nu = 1755.59W/m2k

Nu= hL/k

17555.59 = h(0.3)/0.628

h = 3675.05W/mk

Heat transfer (Q4),

Q 3= hAΔT

= 3675.05x0.424x290

Q 4= 45.188x104W

Case(5):

Tw = 50˚c     ;     Tn = 25˚c

Tf= (50+25)/2 = 37.5˚c

Tf = 310.5 K

Properties of water in saturated state:

υ = 0.757x10-6m2/sec

Pr = 5.340

K = 0.600W/mk

ΔT = 288K

β = 3.22X10-3

Gr = (9.81x3.22x10-3x288x0.33)/(0.757x10-6)2

Gr = 4.286x1011

Gr.Pr = 4.286x1011x5.34

Gr.Pr = 2.289x1012

Natural convection:

Nu = 0.13(2.289x1012)1/3

Nu = 1713.26W/mk

Nu = hL/k

1713.26 = h(0.3)/0.6

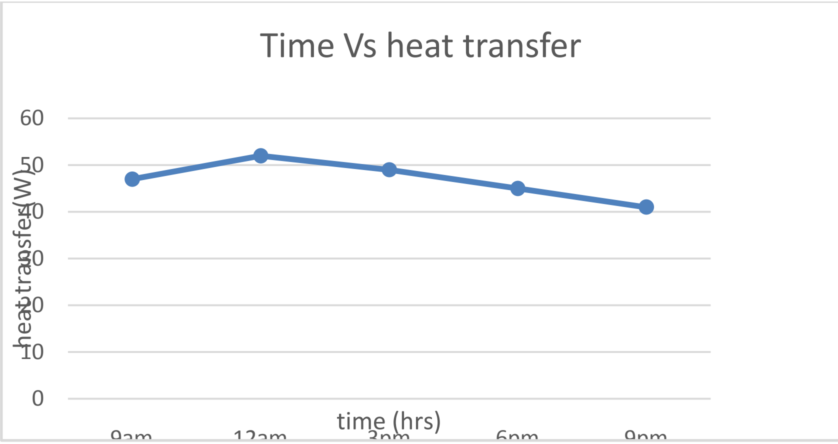
h = 3426.5W/m2k

Q5 = hAΔT

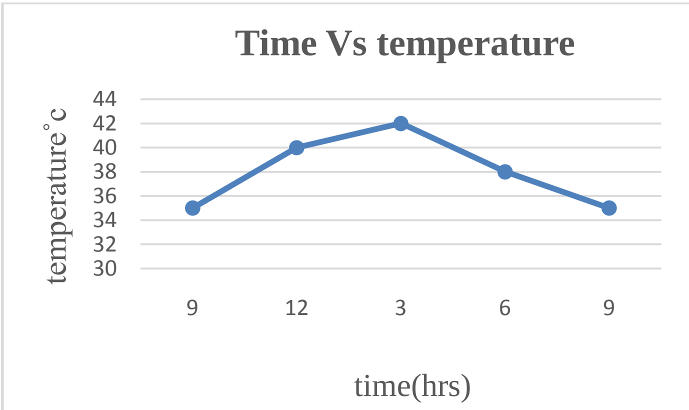
= 3426.5x0.424x288

Q5 = 41.84X104W

**3.4 GRAPH:**

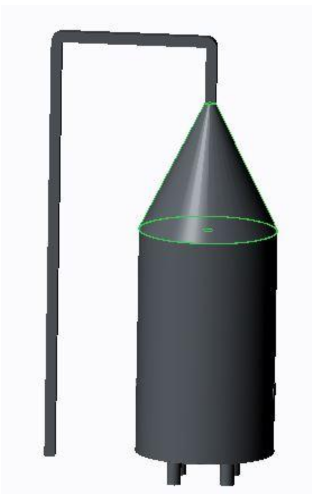



**Graph Time Vs Heat tranfer**




**Graph: Time Vs Temperature**

**PART DIAGRAM** **DRUM SETUP** **WATER HEATER SETUP**



**CONCLUSION**

The “Air pollution control and water heater by using paraffin wax from municipal waste ” is done successfully and the following conclusions are made:

1) The heat transfer from the phase change material is high and the waste heat from the furnace obtained.

2) The heat storage time in the phase change material can vary with time and stored heat used to heat the water .when the time increases the water temperature will be reduced and causes the excess heat to supply from the furnace.

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