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Electrical Energy Steam Boiler Heat Loss Analysis in Japfa Comfeed Indonesia Tbk, Unit of Sidoarjo

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ABSTRACT

In the animal feed industry, steam is used in pellet making machines. In this process, steam from the boiler is distributed to the pellet mill through the pipe. The purpose of this study is to observe the waste of electricity costs of operating a boiler by calculating heat loss in a distribution pipe. The method of assessing heat loss is done by calculating losses caused by heat loss in the boiler distribution. Then make a calculation application model based on the data obtained. From the data, the amount of heat lost in the non-insulating distribution pipe is 0.766 kJ/s with a loss of Rp 5.628,600 operating costs per month compared to heat loss in an isolated pipe condition of 0.047 kJ/s with losses which cost slightly more than Rp 368 190 / month. This heat loss calculation process is made on an android application by entering the calculation formula on the program and the data has been obtained..

Keywords : Heat loss, Electricity, Android
Paper type Research paper

INTRODUCTION

The Steam is one potential source of energy and widely used in various industries. In addition to having many advantages among which temperatures vary, it is appropriate to use heat transfer in exchanger and heat exchangers more, steam also has the disadvantage mainly of it is easy to heat loss due to conduction, convection, radiation and prone to condensation or change phase into water back at a pressure and temperature[1], [2]. Due to the nature of steam, we need a line or lines of different piping of other fluid. One of the conditions is the heat shield that can withstand the heat and prevent heat loss due to radiation.

At the time of the audit, the auditor assumes that the redundancies on operational costs of boiler used. Current conditions for the operational use of boiler capacity of 8 tons/hour of gas-fueled and diesel fuel, with a distribution divided into three parts, namely towards Buhler production unit, for units Fish feed production and feed the birds and to heat the boiler feed tank. Wastage can occur from several factors among which the leak, the pipe installation is less precise, the heat loss in the distribution pipes without insulation or insulation breakdown and many other factors. From these results, the authors want to prove how much waste the cost of electricity for the operation of the boiler due to the heat loss factor in the distribution pipes.

BASIC THEORY

Boiler

A boiler is a closed vessel in which the combustion heat transferred to water to form steam. Steam under pressure is then used for transferring heat to a certain process. If the water is boiled into steam, tsekitar volume builds up to 1600 times, so that the boiler is equipment that must be managed properly. Purified water is pumped through a pipe into the boiler, and then converted into steam by the heat generated from the combustion of coal. At temperatures up to 1000 degrees Fahrenheit and under pressures up to 3500 pounds Specify the square, steam is channeled keturbin. The system consists of steam boiler feed water. Syatem water supply water to the boiler automatically by the needs of the steam used[3].

Heat beautification

Heat transfer is the study of energy transfer in a material because of the difference (gradient) temperatures. Heat transfer is always the case of a system of high temperature to a system other at a lower temperature and stopped after the system reaches the same temperature, the temperature difference is the main condition the occurrence of heat transfer, if both systems have the same temperature there is no heat transfer in both the system. The amount of heat flow is expressed by the notation Q in units of energy are joules (j). Studies of heat transfer is not only trying to explain how heat energy is moved from one another kebenda objects, but also can predict the rate of heat transfer occurs in kondidi particular circumstances. There are three kinds of heat transfer, yaitukonduksi, convection,[1].

Conduction
Conduction is heat transfer in solids of high-temperature region to a low-temperature region. According fourrier, the flow velocity is proportional to the surface area through which heat and the temperature difference and inversely proportional to the wall thickness traversed[1]'

Convection
Convection heat transfer is a mechanism of heat transfer between the solid surface with incompressible and compressible fluid moving and involving conduction as well as the movement of the fluid. The faster the movement of the fluid, the greater the rate of heat transfer konveksinya.Untuklook for the amount of heat loss by convection by entering the following formula[1].

$$Qkonv = hA\ (-Ta) \quad (1)$$

Where :
A = Area of heat transfer

$$A = \frac{\pi}{4}D^2 \quad (2)$$

H = coefficient of heat transfer by convection-free

$$h = \frac{k}{Od}Nu_d \quad (3)$$

h = coefficient of heat transfer
k = thermal coefficient baj
Nud = Nusselt number
OD = outer diameter

Because the process of free convection processes occur on the surface of the pipe then the value of Nusselt number can be determined by the following formula:

$$Nu_d = \left\{ 0{,}60 + \frac{0{,}387\ Ra_d^{\frac{1}{6}}}{\left[1 + \left(\frac{0{,}559}{Pr}\right)^{\frac{9}{16}}\right]^{\frac{8}{27}}} \right\}^2 \quad (4)$$

Nud = Nusselt number
Rad = Rayleight number
pr = Prandtl Number

Finding value Rayleight number

$$Ra_d = \frac{g\beta(T_s - T_a)Od^3}{v\alpha} \quad (5)$$

g = Acceleration due to gravity (9.81 m / s^2)
β = Coefficient of thermal expansion of air (1 / Ta) in units of kelvin
v. α = Kinematic viscosity of air

Radiation
Radiation heat transfer is the process by which heat flows from objects at high temperature to low temperature objects when the objects separated in space, even if there is a vacuum in between objects - these objects.Radiant energy released by the body because of the temperature, which is transferred through the space between, in the form of electromagnetic wave energy radiation When override a material, then some radiation is reflected, partially absorbed and partially transmitted. Untuk mencari kehilangan panas karena radiasi dapat dicari dengan rumus [1]:

$$Qrad = \varepsilon \cdot \sigma \cdot A\ (s4\text{-}Ta4) \quad (6)$$

Where :
ε = emissivitas (0 s / d 0.9)
σ = Stefan-Boltzmann constant (5,67x10-8W / m^2K4)
A = area of heat transfer area (m^2)
Ts = Temperaturpermukaanpadapipa (° K)
Ta = Ambient Temperature (° C)

Motorcycle

The motors are the most widely used in the industry is the type of induction motor. Induction motors consist of a stator with three coils are placed symmetrically on the groove-groove. Known induction motors because the current flowing in the rotor are induced current as a result of the onset of EMF induced in the rotor conductors resulting rotary field stator. There are two types of three phase induction motors are widely used in the industry are the type of rotor cage (squirrel cage) and the rotor convolution (wound rotor) called slip-ring motors[4]. There are some factors that affect the efficiency of electric motors including age, capacity, temperature, speed, and load the motor winding. Because it is difficult to measure the efficiency of the motor in normal operating conditions, the motor load can be measured as an indicator of the efficiency of the motor[5].

APP Inventor

App Inventor is a tool to create android app based visual blocks programming, making it easier for users to design applications without coding, the purpose of visual blocks programming is in use the user will see, use, develop and drag-drops "blocks / puzzle" which is a command or function - specific event handler function to create applications, and simply can be called without writing programming code[6][7].

METHOD

Research sites

This research examines the analysis losspemaakiantekananuap heat boiler or steam boiler that exist on the machine as a support engine production at PT. Japfa Comfeed Indonesia Tbk, Sidoarjo branch.

Tools used

On this research (hardware) needed like one laptop, termograph, stationery, paper and (software) such as MIT software, internet and multiple to preprocessing, processing dan post processing.

Data Collection and Analysis

Field research data collect:

1. Data of research in the field
2. Processing obtained by formulas or equations research data.
3. Analyze research data obtained
4. Conclusion.

DISCUSSION

Boiler steam calculated distribution heatloss analysis on the distribution pipe by means of collecting data in the field, from the data and then enter it into the heat transfer formula. Then calculate how much electric power loss due to the loss of heat. The data that can be in the field is as follows.

Table 1. Specifications and Data Boiler 1 PT. Japfa Comfeed Indonesia Sidoarjo Unit

1	Type	DDHS 8.0 - 10
2	capacity	8,000 kg / h
3	Hetaing surface	185ºC (outlet temperature)
4	Working pressure	8 bar. g
5	Design pressure	10 bar. g
6	Model	RGL70 / 1-B
7	Burnerheat capacity	800 - 7400 KW
8	input	380-415 V / 3 ~ / 50 Hz
9	output KW	18 KW
10	Current	34.5 A
11	Speed	2950 rpm

Table 2. Boiler Pipe Data Distribution

No.	unit	Pipe Length (m)	Diameter (Inch)
1	Buhler	162	4
2	P. Bird and P. Fish	236	4
3	tank Feed	22	2.5

Table 3. Data Pipes Without insulation and insulation damaged

No.	locations	Pipe Length (m)	Pipe Diameter (Inch)	Thick (Mm)	Ts (°C)	Ta (°C)
1	point 1	15	2.5	6	132	38.4
2	point 2	13	4	6	134	39.6
3	point 3	16	2.5	6	103	40.9
4	point 4	20	2	6	150	48.7
5	point 5	20	2	6	150	39.8
6	point 6	15	2	6	129	39.8
7	point 7	13	2	6	150	43.3
8	point 8	10	2	6	95.6	35.1

Analysis of Heat Loss Without Pipe Insulation And With Insulation

Pipe insulation steam without causing any direct contact between the surface of the pipe to the outside air. High temperature difference resulted in the flow of steam is condensed in the pipeline. This rapid condensation of events accompanied by heat loss events due to the heat transfer by convection and radiation. Here is a calculated losses that occur in the steam pipes without insulation and insulation damaged:

1) Location point 1

Known :
Pipe surface temperature (Ts) : 132°C = 405 K
Ambient temperature (Ta) : 38.4°C = 311 K
The length of pipe without insulation : 15 m
diameter Pipes : Inside diameter (Id) = 2.5 "= 63.5 mm
: Thickness (t) = 6 mm
: Outside diameter (OD) = Id + 2t = 75.5 mm = 0.075 m

According to the thermophysical Properties of Gases at Atmospheric Pressure obtained property values 38,4°C air temperature = 311 K is as follows:

Density (ρ) = 1.1614 kg / m^3
the coefficient of thermal expansion (β) = 1 / Ta = 1/308 K-1 = 3,24x10-3 K-1
kinematic viscosity of air (v, α) = 15,89x10-6 m2 / s; 22,5x10-6 m2 / s
Thermal coefficient (k) = 26,3x10-3W / mK
Prandtl number (Pr) = 0.707
Thus obtained Rayleight number of :

$$Ra_d = \frac{9{,}81\frac{\mathrm{m}}{\mathrm{s}^2}.\,3{,}24\mathrm{x}10^{-3}\mathrm{K}^{-1}.(416{,}8\ \mathrm{K}-308\ \mathrm{K}).(0{,}0675\ \mathrm{m})^3}{15{,}89\mathrm{x}10^{-6}\frac{\mathrm{m}^2}{\mathrm{s}}.22{,}5\mathrm{x}10^{-6}\frac{\mathrm{m}^2}{\mathrm{s}}}$$

$$Ra_d = 2{,}95x10^6$$

Thus obtained Nusselt number at:

$$Nu_d = \left\{0{,}60 + \frac{0{,}387.(2{,}95x10^6)^{\frac{1}{6}}}{\left[1+\left(\frac{0{,}559}{0{,}707}\right)^{\frac{9}{16}}\right]^{\frac{8}{27}}}\right\}^2 = 19{,}77$$

In order to get the value of natural convection heat transfer coefficient (h) of:

$$h = \frac{26{,}3\ \mathrm{x}\ 10^{-3}\mathrm{W/m.K}}{0.075\ \mathrm{m}}.19{,}77 = 6{,}93\ \mathrm{W/m^2.K}$$

Heat loss so that the steam pipes without insulation obtained at:

$$Heat\ loss\ (q) = h\,A(T_s - T_a) + \varepsilon.\sigma.A\,(T_s{}^4 - T_a{}^4)$$

$$Heat\ loss\ (q) = \frac{3{,}14(0{,}075)^2}{4}\mathrm{m}^2 6{,}93\frac{\mathrm{W}}{\mathrm{m}^2K}(405\ \mathrm{K}-311\ \mathrm{K})$$

$$+\qquad 0{,}93\,.\,5{,}67\mathrm{x}10^{-8}\frac{\mathrm{W}}{\mathrm{m}^2\mathrm{K}^4}.\frac{3{,}14(0{,}075)^2}{4}\mathrm{m}^2.(405^4-311^4)K^4$$

$$Heat\ loss\ (q) = 2{,}876\ \mathrm{W/m} + 4{,}139\mathrm{W/m}$$

$$Heat\ loss\ (q) = 7{,}015\ \mathrm{W/m}$$

Long known insulated pipes that are not less than 15m long. So that the total heat loss along the pipe without insulation for:

$$Heat\ loss\ (q_1) = 7{,}015\frac{\mathrm{W}}{\mathrm{m}} x\ 15\ m = 105{,}225\ Watt$$

If the surface temperature of pipes with insulation is 45,8oC = 319ºK, then the heat loss is:

$$Heat\ loss\ (q) = \frac{3{,}14(0{,}075)^2}{4}\mathrm{m}^2 6{,}93\frac{\mathrm{W}}{\mathrm{m}^2 K}(319\ \mathrm{K} - 311\ \mathrm{K})$$

$$+ \quad 0{,}93\,.\,5{,}67\mathrm{x}10^{-8}\frac{\mathrm{W}}{\mathrm{m}^2\mathrm{K}^4}.\frac{3{,}14(0{,}075)^2}{4}\mathrm{m}^2.(319^4 - 311^4)K^4$$

$$Heat\ loss\ (q) = 0{,}24\frac{\mathrm{W}}{\mathrm{m}} + 0{,}23\ \mathrm{W/m}$$

$$Heat\ loss\ (q) = 0{,}47\ \mathrm{W/m}$$

$$Heat\ loss\ (q_1) = 0{,}47\frac{\mathrm{W}}{\mathrm{m}} x\ 15\ m = 7{,}05\ Watt$$

So the total without insulation Heat Loss = Q1 + Q2 + Q3 + Q4 + Q5 + Q6 + Q7 Q8 +
= 105.225 + 126.652 + 68.336 + 118.64 + 128.08 + 73.8 +81.393 + 64.386
= 766.512 Watt
= 0.766 KW = 0.766 Kj / s = 0.766 Kcal / s

So the total with insulation Heat Loss = Q1 + Q2 + Q3 + Q4 + Q5 + Q6 + Q7 Q8 +
= 7.05 + 10.5 + 4.35 + 1.95 + 5.4 + 4.05 +1.69 + 12.18
= 47.17 Watt
= 0,047 KW = 0,047 Kj / s = 0,047 Kcal / s

Calculating Power

Looking losses burner cost of electricity used by the heat loss with and without insulation:
Heat known maximum capacity generated is equal to 7400 kW burner and burner motor output power of 18 kW. So the loss of electrical power due to the heat loss is equal to:

$$Power\ Loss = \frac{Heat\ loss}{Heat\ capacity\ maximal}\ x\ power\ output\ motor$$

$$Power\ Loss = \frac{0{,}766\ kW}{7400\ kW}\ x\ 18\ kW = 0{,}0019\ kW = 6{,}84\ kWh$$

If the burner live 24 hours for 30 days (one month) when calculated into rupiah, when 1 kWh in rate OPLT = Rp 1,035, -and WBP = Rp 1.553, - the loss of electric power in the first day of
= (Rp 1,035 x 6,84 x 19) + (USD 1 553 x 6,84 x 5)
= Rp. 134 508, - + Rp. 53.112.-
= Rp. 187 620, -
Electric power loss in 30 days = Rp. 187 620 x 30 = Rp. 5.6286 million, -
Electric power losses in 365 days = Rp. 187 620 x 365 = Rp. 68.4813 million, -
Table 1. show comparing the electric power loss due to heat loss every month:

Table 4. Comparison of electric power losses due to heat loss and premises without insulation.

steam pipe	Heat burner maximum capacity (kW)	Burner motor output power (kW)	Heat loss (kW)	Loss of power (kWh)	Loss costs in one month
without insulation	7400	18	.766	6,84	USD 5.6286 million
with insulation	7400	18	0,047	0.411	Rp. 368 190

Software Aplication

Design of the application uses an application called MIT App Inventor android, android where in the automatic calculation application it will be used as a system. The zoom as follows in Figure 1. :

Fig. 1. App View with Heat Loss Pipe Distribution on 4 point

Testing Applications

This application testing using the data that have been taken in the field. Below is a table of test results against android app manually:

Table 5. Table Testing Applications

	T1	T2	OD	P	H	P. Motor	H. Cap Max	heat loss	Power Loss (kwh)	Cost Loss (USD)
Point 1 Manual	405	311	0.075	15	6.93	18	7400	0,105	0.919	25220.7
Point 1 Android	405	311	0.075	15	6.93	18	7400	.104	0.914	25086.3
Point 2 Manual	407	312	0,113	13	4.6	18	7400	0.126	1.103	30264.9
Point 2 Android	407	312	0,113	13	4.6	18	7400	.181	1.592	43670.4
Point 3 Manual	376	314	0.075	16	6.93	18	7400	0.068	0.595	16333.4
Point 3 Android	376	314	0.075	16	6.93	18	7400	0.068	0.600	16477.4
Point 4 Manual	423	321.8	0,062	20	8.38	18	7400	0,118	1.033	28343.3
Point 4 Android	423	321.8	0,062	20	8.38	18	7400	0,118	1.041	28569.1
Point 5 Manual	423	321.9	0,062	20	8.38	18	7400	.128	1.120	30745.3
Point 5 Android	423	321.9	0,062	20	8.38	18	7400	0,118	1.040	28547.4
Point 6 Manual	402	312.9	0,062	15	8.38	18	7400	0.073	0.639	17534.4
Point 6 Android	402	312.9	0,062	15	8.38	18	7400	0.089	0.783	21485.6

CONCLUSION

Based on test results data in the field and application testing that has been done, it can be concluded miraculous as follows:

1. The amount of heat that is lost in the distribution line due to the steam boiler pipes without insulation or improper insulation of 0.766 kJ / s and total loss of electrical energy is lost by 6,84 kwh. Then converted into rupiah loss in operating costs in half is Rp. 5.6286 million, - / month. When compared with using the distribution pipe insulation the heat loss of 0.047 kJ / s and electrical energy losses of Rp. 368 190, - / month.
2. Losses by pipeline without insulai or lack of proper insulation on the boiler steam distribution lines can be easily calculated using the android application. With our application can easily and quickly get the value of heat loss and the loss of electrical power just by entering the data of field measurements

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