AN ANALYSIS OF DAMAGE ON TUBE REFORMER BY USING *COMPUTATIONAL FLUID OF DINAMICS* (CFD) METHOD

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ABSTRACT---*Reformer is a reactor that happened a "steam reforming" reaction. The reaction involves natural gas and steam or water. That Reformer works to break hydrocarbon become hydrogen. reforming is a reaction process of CH4 + H20 CO + 3H2 that needs a temperature dan high-pressure, that reformer is operated at 800-1000ºC and pressure 2.1 kg/cm^2. It is caused the operational has a high temperature, thus, there is the enduring a symptom of reports of damage or injuries in the sight of elbow carburizing. The damage is caused by some factors, such as oxidation, carburazing (metal dusting), nitridasi, corrosion by halogen, corrosion by molten metal and deposit ashes or salts Carburization (metal dusting), Creep, Thermal shock, Prolong overheating, and Short term overheating. The causes of damage are in the sight of elbow tube reformer and CFD (Computational Fluid Dynamic) simulation. Based on the analysis of CFD simulation, then the elbow of the tube reformer that undergo oxidation, which means erosion corrosion due to thinning of the elbow is uneven and the formation of small particles resulting in the erosion of material at the elbow reformer tube, to Perform a precautionary measure, it is in the area elbow granted coating the surface with a coating of boron carbida, in order to obtain a surface layer that is resistant to wear and low friction and is also resistant to erosion, surface coating on the side of the elbow can be done by way of boron carbide coating thickness of 05 µm - 1.00 µm to obtain a surface hardness high and high wear resistance and a low friction korfisien. Perform routine maintenance in accordance with the operational requirements of managing and maintaining the operational gas flow rate is maintained.*

Key words--- *reforme, elbow, CFD (Computational Fluid Dynamic).*

I. Introduction

Background of the Research

Reformer reactor where the reaction is "steam reforming". Ie reactions involving natural gas with steam or water, with the reaction equation as follows:

CnHm+nH2O===nCO+(n+m/2)H2(-ΔHo298<0)

CH4+H2O===CO+3H2(-ΔHo298=-49.27kcal/mol)

CO+H2O===CO2+H2(-ΔHo298=9.84kcal/mol)

Steam reforming reaction requires heat for the endothermic reaction. Heat requirements are very large so it takes a good heat transfer. To get a good heat transfer required a large surface area. Therefore, reformer reactor made in the form of a

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reed (tubular). What is meant is a reformer tubular reactor (where the reaction) wherein the catalyst is inserted into the tube and then placed in a furnace equipped with a burner and then burnt using fuel gas / gas in general. Where the results are processed in the reformer tube. The reformer serves to break the hydrocarbons into hydrogen gas. The process is the process of reforming reaction CH4 + H20 CO + 3H2 which require high temperature and pressure. reformer tube is typically operated at a temperature of 800 to 1000ºC and pressure 2.1 kg / cm2 and can cause damage in the area around the elbow on the reformer tube. Some of the possible damage to the elbow, so that it can lead to damage / leakage. From urain above components are operated at high temperatures and pressures are particularly at risk for damage such as carburization (metal dusting), Creep, Thermal shock, Prolong overheating, and Short term overheating.

Formulation of The Problem

The formulation of the problem in this research are:

1) How is the operation of the Reformer Tube is already in accordance with SOP (Standard Operating Procedure).
2) How to perform repairs and maintenance on the reformer tube.

Objectives of the Research

The objectives of the research are:

1) To analyze the cause of damage such as carburization reformer tube (metal dusting), Creep, Thermal shock, Prolong overheating, and Short term overheating.
2) Determine the measures of preventive and predictive maintenance to avoid similar damage in the future.

II. Theoretical Review

1. Reformer

Reforming reaction is a reaction to the formation of hydrogen gas from hydrocarbon raw materials. Hydrocarbons in question can be derived from natural gas, naphtha, coal, petroleum, etc. However, when compared with other, natural gas containing light hydrocarbons at most, namely in the form of methane. Methane is used as a raw material for steam reforming reaction because it provides the most amount of hydrogen compared to other chain alkanes longer.

2. Steam Reforming Reaction

Thermodynamics reforming reaction is highly endothermic reaction, so the reaction would be better carried out at high temperature and low pressure while the shift reaction is an exothermic reaction which are better performed at low temperatures. In addition, the steam reforming reaction is an endothermic equilibrium reaction, so it is thermodynamically, equilibrium constants will increase with increasing temperature. In this reaction, the reaction equilibrium is not influenced by the partial pressure of the components involved in the reaction. Thus, to maximize the overall efficiency and ensure the ongoing process runs economically, the formation reaction of synthesis gas in a reformer is operated under high temperature and pressure.

3. Reforming Primary

Primary reformer is the scene of the reactor feed gas reaction with steam into synthesis gas (H2, CO, CO2). This reaction is endothermic in total and thus require heat to be able to react. The heat required in the supply of 80 arch burner that produces temperatures of 823oC riser. The reaction of the Primary Reformer, natural gas is reacted with steam by using a nickel catalyst to the reaction as has been mentioned above. This energy supply is obtained through the radiant section and the convection section on the primary reformer. Temperature, pressure and steam flow rate should be maintained properly to prevent coke formation reactions that can result in overheating and destruction of the catalyst.

4. CFD (Computational Fluid Dynamics)

Computational Fluid Dynamics (CFD) is a method of calculating a control dimensions, area and volume by utilizing the computing help the computer to perform calculations on each element of the denominator. The principle is a space that contains a fluid that will do the calculation is divided into several parts, it is often called the cell and the process is called meshing. The parts which are divided into a control computation to be performed is application. This calculation controls along kontrolkontrol other calculation is a division of space mentioned earlier or meshing. Later, at each control point calculation calculation will be done by the application with domain boundaries and boundary condition that has been determined. This principle is widely used in the counting process with the help of computer computation. Another example of the application of this principle is the Finite Element Analysis (FEA) is used to calculate the voltage that occur on solid objects.

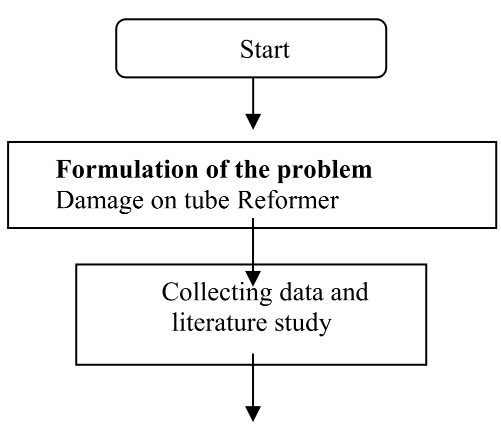
5. Material Sandvik

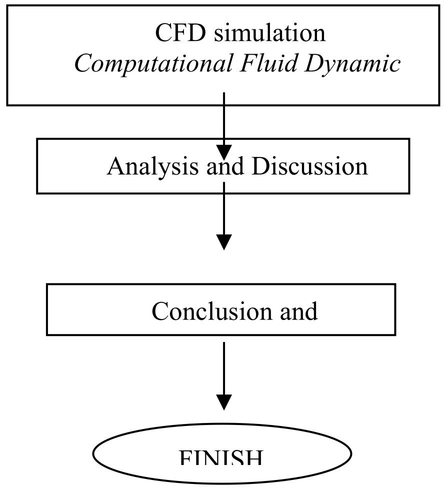
Sandvik 353 MA 353 MA is a material austenitic chromium-nickel stainless steel tube is able to contribute lifespan and reduces maintenance (maintenance) applications using high temperatures. Combined with rare earth metals (REM) and nitrogen, Sandvik 353 MA is characterized by high performance in a process of oxidation, carburizing and nitriding environment. Sandvik 353 MA is a steel chromium-nickel austenitic is a blend of rare earth metals with nitrogen This class is characterized by:

• Strength creep High
• Durability very good for an isothermal process and the oxidation of cyclic
• Durability very good for the combustion process gases
• Resilient excellent for carburizing
• good resistance to gas nitriding • excellent structural stability at high temperatures
• Have a good weldability maximum operating temperature is approximately. 1175 ° C. (2150 ° F)

III. METHODOLOGY

Here is an overview of the study flow diagram that generally describes the methodology or steps in analyzing the cause of the malfunction or failure of the reformer tube using CFD simulation (Computational Fluid Dynamic)





Picture 1 ***Flow Chart*** **Research**

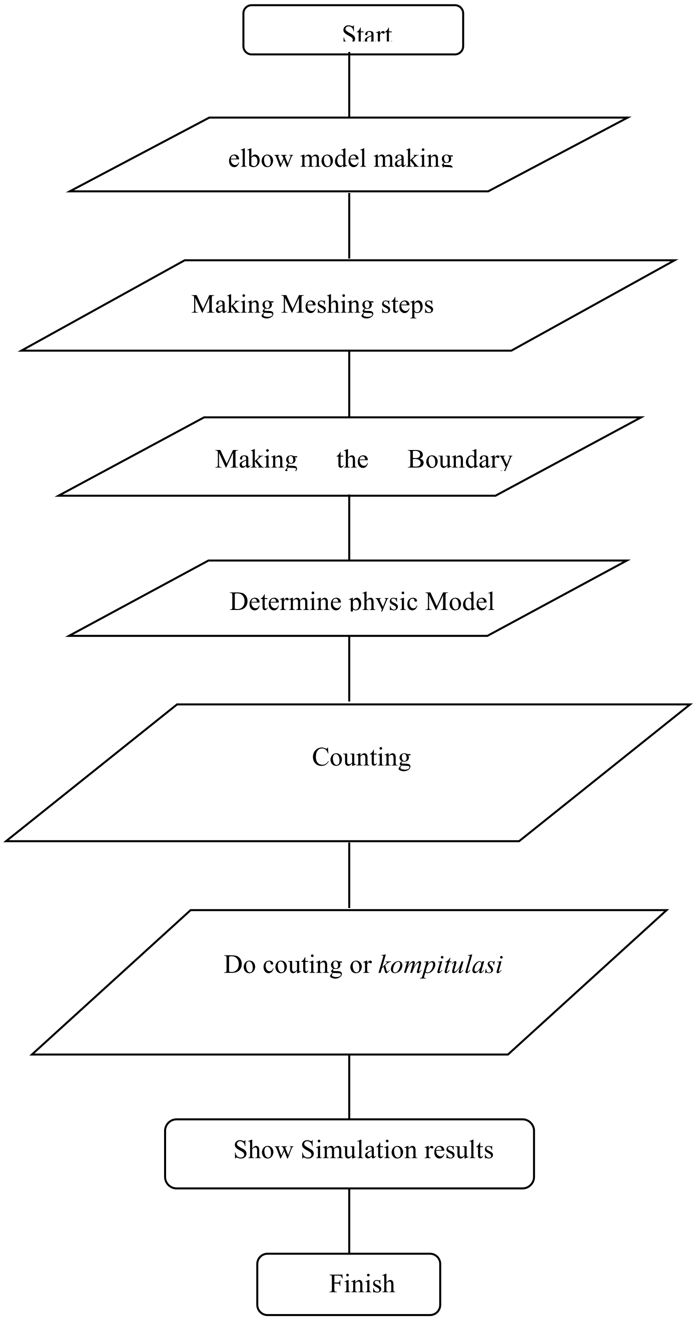
IV. FINDING AND DISCUSSION

1. Stage Design of Elbow Tube Reformer and stages of the simulation process

A. Simulation Steps

To facilitate the process of simulations in this section will be described in a gradual process that starts from forming simulation geometry. The overall process consists of six steps:

1. Make a model of spiral pipes
2. Make mesh
3. Determining boundary condition
4. Determining the physical condition of the model
5. Determine completion parameters and run the simulation

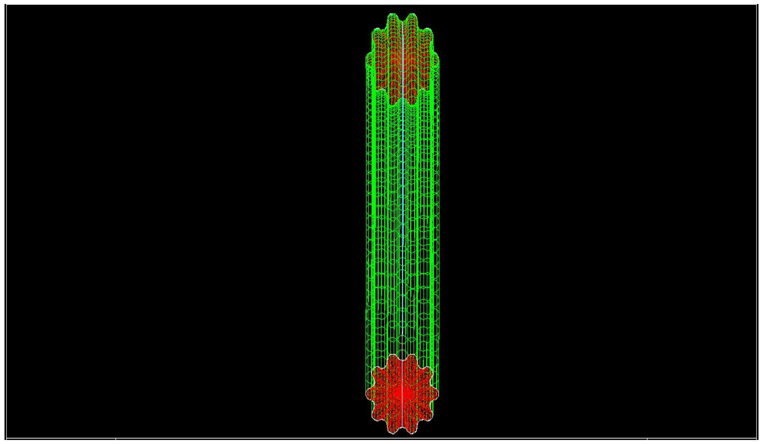


2. Making Elbow Model Tube Reformer

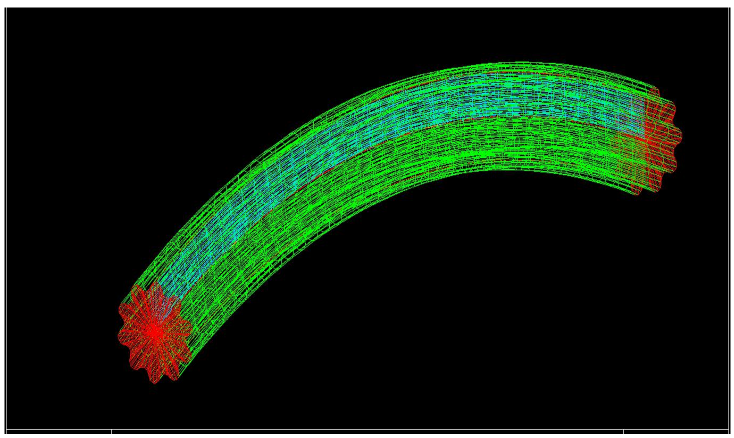
Things need to be done first before doing the simulation process is to model the flow that occur in spiral pipe. In this case the model is made is in the form of volume models. Simplifying assumption that models do is to take the thickness of the pipe is negligible. In making the model uses CATIA as a model maker.

a. Meshing

Meshing is a process whereby the overall geometry is subdivided into small elements. These small elements will act as a control surface or volume in the calculation process and then each of these elements will be input to the element next to it. H al this will happen over and over again until the fullest domain. In meshing elements that will have adapted to the needs and geometric shapes.



Picture 1. grid elbow tube reformer result



Picture 2. Grid elbow tube reformer result

b. Making *boundary condition*

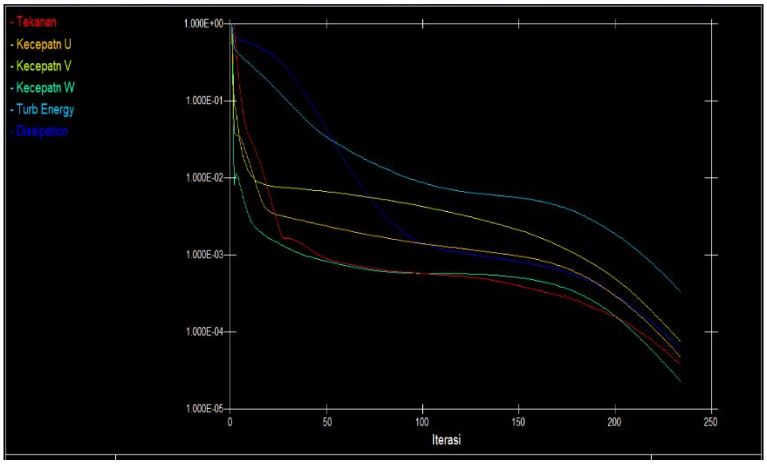
Boundary condition is the definition of the zones have been defined previously in the application gambit. In fluentlah the values and characteristics of each boundary type, as defined earlier in the gambit, defined. Because the models used are simple models of water flow the boundary condition is possible and appropriate to define the actual situation is velocyti inlet for the entry of water from the pump. And exit the exit point of the water from the pipe spiral.

c. Determine the physical condition of the model

Things to do next is to determine the physical condition of the model is the determination of the completion of the model, the fluid used and the conditions

d. Determining the numerical calculation parameters

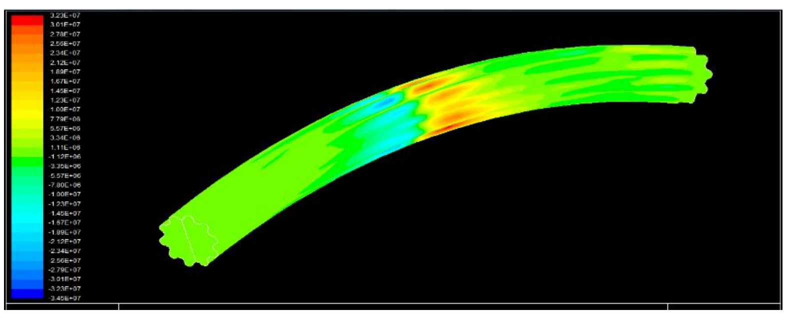
When finished defining the model to be simulated, the next stage is to determine the numerical calculation parameters to be used as the control solution, conducting initial initialize, monitor residual, and then perform the iterative process of simulation, the iteration process will stop after convergence. At the time of the iterative process it will show the residual Garik as shown below.



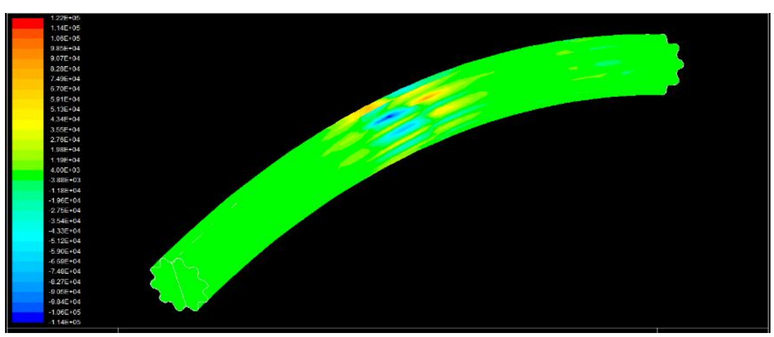
Gambar 3. Grafik residul

e. Show Simulation Result

After reaching the convergence of the solution, then the next stage is the stage to see the results of simulation that has been done. In looking at the results of simulation of fluent can be done in various ways, viewed as a whole as well as specific targets to determine the field, line or observation point. Because the main target was to see how where the effect of changes in the diameter of the pressure drop from the inlet to the outlet, it will be the velocity vector of either the whole or fields made before, and contour as well as view the flow line (path lines) to determine whether the flow that occurred have been effective or not.



Picture 5. Speed x Static



Picture 6. Speed X constants

V. RECOMMENDATION

ELECTION Materials For High Temperatures

Materials that are operated at higher temperatures up to about 750 ° C, such as power generation industry environment (power generation), petrochemical and other chemical industries, oil refineries (oil refining), *waste incineration*; berupa peralatan ste*am boiler, heater tube,* rec*overy boiler, reactor vessel, process piping*, dan *flue-gas recovery equipment;* umumnya dimanfaatkan *carbon steel* (< 1% Cr) dan *Cr-Mo steel* (1-12% Cr dan 0 – 1% Mo).

- For applications up to 1,150 ° C is generally used Cr-Ni-Mo steels containing 12-25% Cr and 5-25% Ni. This material strength at high temperatures better on the basis of austenitic structure and content of high nickelnya. In addition, reducing the weakness of ferritic steels (eg, Cr-Mo steel feritis with Cr> 12%) were lost toughness after being exposed for long periods in hot temperature conditions.
- To coat the surfaces with boron coating carbida, in order to obtain a surface layer that is resistant to wear and low friction and is also resistant to corrosion, the coating surface on the side of the elbow can be done by way of boron carbide coating thickness of 05 μm - 1.00 μm to obtain high surface hardness and high wear-resistant and low friction korfisien.
- Promoting the routine maintenance in accordance with the operational requirements of maintenance.
- Setting the operating flow rate is maintained.

VI. CONCLUSION

Based on the simulation program CFD (Computational Fluid Dimanic), analysis of the damage that occurs in the elbow tube reformer, it can be summed up as follows: The cause of the damage in the area of the elbow tube reformer is because since the flow in the tube reformer turbulent, causing wear and tear erosion (erosive wear) on the side of the elbow which causes the reformer tube thickness is reduced which is characterized by a very significant erosion in the area around the elbow of the reformer tube, and the flow of this turbulence can cause stress concentrations substantially in the area around the elbow.

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